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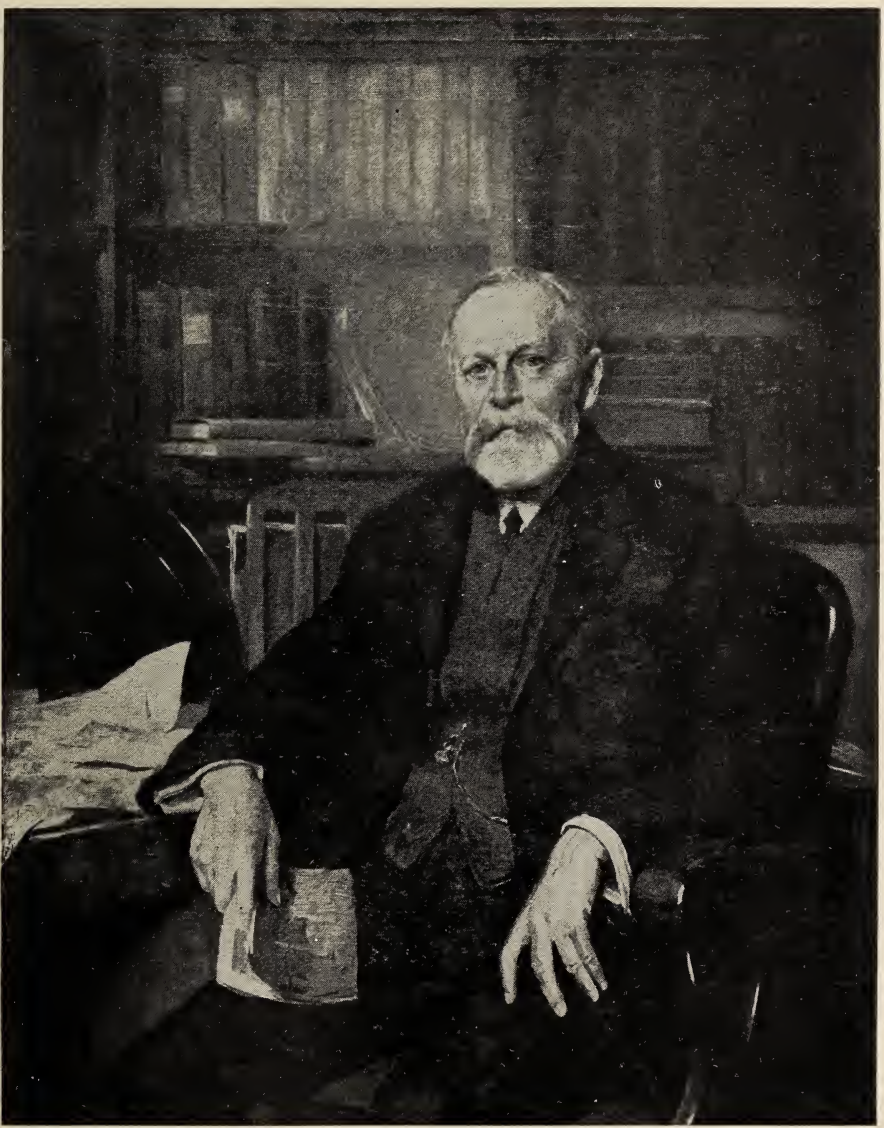
№ 34 1920-21

# The Transactions
of
# The University of Toronto Engineering Society

*With which is incorporated the* Applied Science

UNIV. TORONTO APPLD SCIENCE.

PUBLISHED BY THE SOCIETY



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# PREFACE

THIS IS THE FIRST issue of the TRANSACTIONS since the birth of *Applied Science* as a monthly in 1907. It is the first publication of the Society since the last issue of *Applied Science* in 1916. Therefore, if it does not meet the standard set by our predecessors may those who come after profit by our shortcomings, and remember that all things have to have a start.

Toronto, April 15th, 1921.

# ...Foreword...

by

## OUR DEAN

□□

The Engineering Society is in a period of transition. Through all its history its main function has been the presentation of papers of interest and use in Applied Science and Engineering, and one of its duties to both the graduate and undergraduate body has been the publication of these papers. Throughout the war this process was much interfered with, and the excellent publication, "Applied Science," which was so popular before the war, was necessarily discontinued.

The publication of the Society's transactions is now being resumed, but in the interval since pre-war days the Society has expanded and has so considerably altered its constitution, embracing its various sections, that the nature of the proceedings and the Society's activities are much more comprehensive, and the published transactions will in consequence be much enhanced in value. This present volume ought to prove of considerable value to students and graduates alike, and the Society is to be congratulated on its production.

The Engineering Society has indeed become a most important factor in the University and the student activities of the Faculty of Applied Science. It is fortunate that such is the case at this particular time, when the Faculty is in its growing period, and during the revival after the war, because the success of both Faculty and Society are bound together.

The Engineering Society, with its new constitution just adopted, is entering upon a new cycle, and with its various interests and objects will have an increasing influence with the students in this Faculty. With the increase in numbers and the greater scope of work being planned for the Faculty, the Society will go forward afresh. But it will advance just in proportion to the energy, the initiative, and interest displayed by the members, and their activity will be the measure of its success. The various forms of work in and for the Society are nowadays a part of Engineering Education, and it is important that all members take an interest in the Society's work in this respect.

The authors, officers, and others concerned in the preparation and publication of this very interesting collection of papers are to be complimented upon their subject matter and excellence, and it will be recognized that this volume of the Society's transactions will be an index of the success and very flourishing condition of the Society during the past year.

March 1921.

C. H. MITCHELL,
Dean.

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THE TRANSACTIONS of the
University of Toronto
Engineering Society
WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 34 TORONTO, APRIL 15, 1921 1920-21

# APPLIED SCIENCE AND RECONSTRUCTION

## Dean Mitchell's Opening Address to the Engineering Society, October 7th, 1920.

DEAN MITCHELL opened his address by pointing out the present insistent call for science and applied science, not only in Canada, but throughout the world.

Although the war set Canada back on the road of progress by six years, yet applied science has been given an enormous impetus by the war,—and we have emerged from it with the consciousness that life to-day is a scientific life.

The importance of the University training of young engineers and scientists can hardly be overstated, but a man must be prepared to humble himself at the end of his University course, and to enter his chosen field at the very bottom. This is essential, but the early training of the University added to the immediate training which a man gets in his profession or business career is bound to make him succeed in the end, and to a degree beyond the possibilities of an untrained man.

We are now starting afresh after the war; we ourselves have much lost time to regain, but when we see the turmoil that still exists in Europe we realize keenly that it is only by applying all our energies, whether scientific or otherwise, to keeping things on an even keel in Canada that we can win out in the next few years of reconstruction.

In this process of reconstruction, the application of science is coming and must come to the rescue. And what can science and applied science do for Canada at this particular time? Canada has immense resources from the fisheries of Nova Scotia to the timbers of British Columbia,—and she has human resources as well.

Her human resources have been exemplified beyond any criticism in the last five years of war, and by Canada's part in the Empire. Her human resources are now well proved. But although part of my work as Dean of this faculty deals with human resources what I want more particularly to deal with this afternoon is the material resources of Canada. I do not wish to merely list our undeveloped resources, but to show the activities by which these resources are now being developed by the application of science.

Let us glance at the railways. We are considering building two lines of railways to open up the iron mines and the timber limits of James Bay. Without saying anything to commit me, you all know that there is at present a large project talked of in Ontario concerning electric railways.

Speaking of transportation, the activities in road-making are pronounced in all the Provinces, owing largely to motor car traffic. As for water transportation, tens of millions of dollars are being spent upon the Welland Canal, and people are talking of a St. Lawrence deep waterway. Dry docks are being built in the East and West and on the Great Lakes. Harbors are being deepened and improved.

Now we come to power. Ontario is not the only Province that is planning and executing large power projects. Almost all the Provinces have some power development schemes on hand.

Time does not permit of even mentioning the many other public utilities. We will now touch upon our industrial life. We have many shipbuilding concerns,—mostly steel; we have large steel resources which we can soon develop electrically; new flour mills are being built.

Immense resources of crude oil are being found in Northern Alberta; Canada is refining her own sugar—there are at least two huge sugar refineries on the Atlantic Coast.

Turn for a moment to articles of cement, rubber and leather, which are being developed at a great rate. The most active economic industry is that of paper. People are building paper and pulp mills all over the country.

There are billions of dollars worth of low grade iron ores, copper, and nickel in Northern Ontario awaiting development. The area of Northern Manitoba and Eastern Saskatchewan is amazingly rich in gold, silver and copper.

The chemical industry developed by the war is turning its hand very successfully to the production of industrial chemicals. At Trenton they are making acid phosphate; at Shawinigan, acetic acid, while in Saskatchewan synthetic Epsom and Glauber's salts for the treatment of leather are being made from the alkalies of the prairie. Attempts are being made to briquette the low grade lignite coal of the prairies. This is now a proved success.

Now I have run through all this category of the activities of our material resources, and in closing I can only say, that it is by the education of our human resources and the application of scientific methods that the development of the country can proceed. And with the development along these lines we can see before us the winning of our war of reconstruction; and to that I am sure we are all looking forward as an opportunity for great public service on behalf of our country and our Empire.

# SIR KENELM DIGBY'S THEORY OF LIGHT*

By William Renwick Riddell, B.Sc., LL.D., Etc.,
Justice of the Supreme Court of Ontario.

SIR KENELM DIGBY, born 1603, was one of the best known and most admired philosophers of his own day and those immediately succeeding. He is quoted approvingly by many writers during the 17th and 18th centuries, but is now more than a name only from his amazing "power of sympathy." The disrepute into which this curious medicament fell brought ridicule upon its advocate and has had a disastrous effect upon his reputaton—a disaster almost wholly undeserved.

He was an acute philosopher as philosophy was then understood, well read in the Greek writers, particularly Aristotle, and in Bacon, Descartes, Galileo, Gilbert and Harvey. He was an accurate observer of the phenomena of nature, but hardly a success in his experiments.

Educated at Oxford, which he left without a degree, he spent some time in France and Italy, and was subsequently employed at Court. He took out letters of marque and had considerable success over the French, Spaniards, and Venetians. He was one of the most noted of English Catholics, and was Chancellor to Queen Henrietta Maria; he was banished in 1649, and for four years lived most of the time in Paris, busy with his chemical experiments. He made his peace with Cromwell and lived, from 1653 until his death in 1665, in England, a Fellow and on the Council of the Royal Society at its institution in 1663. He died in 1665 and lies buried in Christ Church, Newgate (1).

His chief philosophical work is entitled "Of Bodies and of Man's Soul"; it is composed of two parts, and first appeared in Paris in 1644 (2).

The work was written for his son Kenelm and was intended to deal chiefly with his "main great theme, the Soul" and its immortality, the discussion of bodies, though the greater part being really introductory and subsidiary (3).

It is in the first part that his theory of light is to be found. At this time there was still some remains of the age-old dispute as to the nature of light—the favorite theory, being that of the Pythagoreans and Platonists, that it consists of exceedingly minute but still material particles, propelled longitudinally from the surface of the body seen and striking the eye (4). Aristotle held that light was an "activity" (energeia), i.e. what Digby calls a "quality" which is analogous to the meaning of Tyndall when he calls heat a "mode of motion."

He begins his treatise with "Quantity (5) among those primary affections which occur in the perusal of a Body;" he shows that this is "Extension" expressed by a determinate number of lesser extensions of the same nature and "therefore nothing else but divisibility;" and he declares that it is impossible that it is composed of "points of indivisibility."

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*Paper presented to the Engineering Society, November, 1920.

With the almost universal confusion of his times he does not accurately distinguish between a body and its qualities—between number as such and extension—and the like; but his argument is easily followed:

He proves that indivisibles cannot make quantity—or to employ our modern terminology, the parts, however small into which matter can be divided, are not indivisible—that is matter is always matter and never "a Monad having position." His proof is taken from Euclid's Elements, Book VI., Prop. 10, by which "Euclid hath demonstratively proved beyond all cavil that any line whatever may be divided into whatever number of parts—an hundred, a thousand or a million.

Digby meets and answers various objections—some wholly metaphysical and none requiring notice here.

Then after a discussion of rarity and density (6) and the bodies possessing these qualities, for he considers them two distinct qualities (as were in his view heat and cold, wetness and dryness, etc.), he attacks the opinion of some philosophers that rarity is produced by the mixtion of "vacuity" among bodies—in our modern terminology, that the ultimate molecules of matter are of the same weight and the mass of matter in a body depends on the nearness of the molecules to each other. He quotes against this view Aristotle's dictum (on the fourth book of his Physics) that there can be no motion in vacuo, but admits that Aristotle may be speaking of a "vast inanity," and not so little ones as no body whatever can come to, but will be bigger than they." His chief argument is this—Galileo gives water 400 times heavier than air, Marinus Ghetaldus gold 19 times heavier than water, therefore gold is 7600 times heavier than air—consequently if the deprecated theory is sound "air will . . . appear to be like a net whose holes and distances are the lines and threads in the proportion of 7600 to 1; which were too great an absurdity to be admitted" (7). Why, Digby does not say.

This is a fair sample of much that passed for scientific proof at the time.

Having now, as he thinks, quite established the innate qualities of Density and Rarity, he defines his terms, "we may with reason call those things dense wherein a man finds a *sensible* difficulty *to part* them, and those *rare* wherein the *resistance* is imperceptible."

He then proceeds to apply gravity or weight to produce the "four first bodies called elements." Gravity with density produces wetness and dryness—when gravity works more effectively than density it forces the parts of the body to "turn to the centre, so become fluid and moist," but if in "weighing rarity against gravity it happen that the rarity overcame the gravity, then the gravity will not change the figure . . . but what figure it has from its proper natural causes the same will still remain. . . . and consequently such a body will have terms of its own and not require an ambient body to limit and circle it in, which nature we call dry." While the quality of a body which "the more easily receives its figure from another (containing it and circling it) we attribute to wetness and moisture." In a word a body which stands by itself and can maintain its form is dry, but one which cannot is wet. Dense bodies are not necessarily dry nor rare bodies wet, but "heat is a property of rare bodies and cold of dense ones." This is assumed and stated without any, even the semblance of, proof.

Digby is puzzled by the paradox that of dense bodies the less dense is the more cold, but of two rare ones the less rare is the less hot—his terminology prevents him appreciating that the two statements express the same thing differently worded.

Now he comes to grips with the elements and is convinced by what to our modern thought is an extraordinary piece of sheer empty verbiage that "the number of elements assigned by Aristotle is truly and exactly determined by him; and there can be neither more or less of them. . . the conjunction of gravity with these two (i.e. rare and dense bodies) breeds two . . . sorts of combinations, each of which is . . , twofold . . the one extremely hot and moderately dry . . . another extremely humid and moderately hot . . , another extremely cold and moderately wet and another extremely dry and moderately cold. . . Fire, Air, Water and Earth" (8). These elements are again compared thus, "What makes itself and other things be seen as being accompanied by light, is called *fire*; what admits the illuminative action of fire and is not seen is called *air*; what admits the same action and is seen . . . is called *water*; and what through the density of it, admits not that action, but absolutely reflects it, is called *earth*" (9).

He adds to the difficulty of our understanding precisely what he means—if he had any clear idea at all—by saying that though he had pitched on the four bodies of fire, air, water and earth, "it is not my intention to affirm that those which we ordinarily call so and fall daily within our use are such as I have expressed them; or that these philosophical ones . . have their residence or consistence in great bulks in any places of the world be they never so remote—as fire in the hollow of the moon's orb, water in the bottom of the sea, air above the clouds, and earth below the mines. . . These notions are only to serve for certain ideas of elements by which the forenamed bodies and the compound of them may be tried and receive their doom of more or less pure and approaching to the nature from whence they have their determination. And yet, I will not deny that such perfect elements may be formed in some very little quantities in mixed bodies, and the greatest abundance of them in these four known bodies that we call in ordinary practice by the names of the pure ones, for they are least compounded and approach most to the simpleness of the elements."

To use the Platonic term, "idea," enables us to translate this into modern language thus:—

"What I have called fire, air, water and earth are not really what are generally so called; but certain matter existing only in theory (speaking generally), the terminology is employed for convenience only, and to indicate the quantity of heat and fluidity possessed by a body. There may, indeed, be certain small ingredients of a body with the ideal quantity of heat and fluidity, but such is not to be expected in great quantity anywhere."

This thought every now and then escapes Digby; but he has it generally, if only subconsciously or unconsciously, and it must not be lost sight of by anyone desiring to comprehend his philosophy.

Comparing the elements, he finds fire more active than water or earth, "as will appear clearly if we consider, how, when fire is applied to fuel and the violence of blowing is added to its own motion, it incorporates itself with the fuel, and, in a small time converts a great part of it into its own nature and shatters the rest into smoke and ashes.

All which proceeds from the exceedingly smallness and dryness of the parts of fire, which being moved with violence against the fuel and thronging in multitudes upon it, easily pierce the porous substance of it like so many extremely sharp needles (10). Here we have a new assumption, viz., that the ultimate particles of fire are exceedingly small—nothing so far has been said to indicate that they are smaller than those of any other element, but the alleged fact continues to be tacitly assumed.

And now he attacks the problem of light. He refuses to follow Aristotle in his view that light is a "quality," denying it any bodily subsistence, although there has followed him almost all the world ever since."

Digby confesses that he does not know what philosophers ordinarily mean by "qualities," and he is confident "neither do they;" and a modern can sympathize with him, for these so-called philosophers made a quality a sort of entity, distinct from the body it accompanied, and yet denied it a subsistence.

The gastric juice digested the food by virtue of a quality of digestion it had; water flowed by virtue of a quality of fluidity, medicine healed by the virtue of a quality of healing, etc., etc.

Digby considers that heat is nothing, but the very substance of fire, "a continual stream of parts issuing out of the main stock of the same fire that enters into the wood and by its rarity makes its way through every little part and divides them," a conception as alien from our own modern ideas as that of the philosophers with whom Digby disagrees.

He boldly asserts that light is not a quality (11) and converts the arguments, five in number, of those who hold the view that it is a quality and not a substance. The first is that it illuminates the air in an instant and therefore cannot be a body, for "a body requires succession of time to move in, whereas light seems to spread itself over the whole hemisphere in an instant;" the second, that two lights can be in the same place, while no body can admit another into its place without removing therefrom; the third, that if light is a body it can be none other than fire, "the subtilest and most rarefied of all bodies whatever, and must be accompanied with heat; the fourth, the sudden extinction of fire, for "what becomes of that great expansion of light that shined all about when a cloud interposes itself between the body of the sun and the streams that come from it?" and the fifth, that if light were a body it would be shaken by the winds and by the motion of the air. As to the two first objections Digby rightly conceives them to be contained in substance in the third, because they are based upon peculiarities wherein light has a resemblance to fire, and as to the third he says that light is fire—not, indeed, fire in every form or fire joined with every substance that expresses itself by light, but fire extremely dilated and without mixture of any gross body. And as fire, so light is corporeal. He supports this statement by an extraordinary argument:

> "Let me hold a piece of linen or paper close by the flame of a candle and by, little by little, remove it further and further off; and methinks my very eye tells me, that there is upon the paper some part of that which I see in the candle, and that it grows still less and less as I remove the paper further from it; so that if I would trust my sense, I should believe it as verily a body upon the paper, as in the candle, though infeebled, by the laxity of the channel in which it flows."

Plainly he takes the light reflected from the linen or paper for a material deposit upon the linen or paper! Having persuaded himself by arguments of no greater validity than that just mentioned" "of the corporeity of this subtile thing," light, he proceeds to answer the third objection, that if light were fire it must heat as well as enlighten, by saying that "there's no dobut but it doth so as is evident by the weather glasses and other artificial musical instruments as organs and virginals which Cornelius Drebbel (that admirable master of mechanics) made to show the King, all of which depends upon the rarefaction and condensation of some suitable body conserved in a cavity within . . . the instrument (12). He thinks the ancient miracle of Memnon's statue which sang at sunrise was "a juggle of the Ethiopian priests made by the like invention." (13). Our bodies, indeed, do not always feel the heat, for we cannot feel heat unless it be greater than that which is in our sense, and "it is very possible that an exceedingly rarified fire may cause far less impression of heat than we are able to feel."

He compares "dilated fire" with "dilated water," when a basin of water is converted into steam, the "virtue of wetting" is reduced in proportion as the basin is less than the room; and so with dilated fire. "As dilated water may be again condensed, so dilated fire may, by the aid of glasses, be condensed to as much as it is (for example) in the flame of a candle, and then that fire or compacted light will burn much more forcibly than so much flame." This very experiment of the Burning Glass Digby considers to prove conclusively that light is fire and "nothing but fire in its own nature and exceedingly dilated."

Having now, as he thought, satisfactorily answered the third objection, he proceeds to the fourth, which asks what becomes of the light when it dies by the intervention of a cloud or the like. The adversary says that he might believe light to be fire if after it went out there were "any ashes remaining, but experience assures us, that after it is extinguished it leaves not the least vestige behind it of having been there."

The objection he rather evades than answers, he asks the adversary to tell "what becomes of the body of a flame which is continually dying, and being renewed by fresh fuel and leaves us no remainder behind it," and "when he hath well considered this, he will find that one answer will serve for both."

Digby is too honest to accept support for his theory from an experiment—a nobleman of much sincerity and a "singular friend" of his told him, that by means of glasses of peculiar construction and arrangement he had seen the sunbeams gathered together and precipitated into a brownish or purplish red powder, in some days nearly two ounces. Digby believes that the substance deposited was something which came along with the sunbeams and no part of them—we would say it was a simple swindle, especially when we learn that the powder was a "magistry" or a philosophers' stone "of a strange volative nature," which could pierce into gold itself in a very short time (14). And he is justly incredulous of the perpetual lamps with incombustible lights, alleged to have been found in tombs—before he undertakes to explain that he wants to see them "undoubtedly proved"—a wise precaution which certainly relieved him from any explanation.

He now returns to the second objection, based upon what we call the impenetrability of matter, viz., that two bodies cannot occupy the same place at the same time, whereas the sunbeams enlighten all the air and the light from two or more candles is everywhere in the same room. So far as the air is concerned, the answer is easy. The air, being a light divisible body, yields without resistance as much space as is requisite for light. It is not at all necessary that the light should be in "every point or atom of air, but to make us see it everywhere it suffices that it be in every part of the air which is as big as the black or sight of our eye (15), so that we cannot set our eye in any position where it receives no impression of light," which is pretty bad logic, but he supports it by a most ingenious argument. The motes seen in a sunbeam sent through a cranny do not admit the light within themselves, but reflect it—still, immovable as they are, they do not prevent one seeing through the air; and consequently *a fortiori*, those parts of the air which are not penetrated by light cannot be supposed to check our vision.

Then as to the supposed fact of two or more lights in the same place, he treats of the exceeding minuteness of the particles of light. A great mathematician not named in the text, but identified in a note as Willibrod Snell (16) had calculated that the flame from gunpowder was 125,000 greater in extension than the gunpowder, and therefore might pass 125,000 rays of light in the space of the least part of gunpowder, which would be absolutely invisible to us on account of its minuteness.

"Wherefore seeing that one single light could not send rays enough to fill every little space of air that is capable of light . . . it is obvious enough to conceive, how, in the space where the air is, there is capacity for the rays of many candles."

Digby postpones his answer to the fifth objection, in order to deal with what he considers the most powerful objection to the corporeity of light, that is, "that its motion is performed in one instant and therefore cannot belong to what is material and clothed with quantity" (extension). He refers to the ring of light seen when children whirl round the firesticks to prove that the motion of light cannot be descried, and that indeed no argument can be made from thence to prove that light is not a body" (17). The question is then asked why light travelling with a great velocity does not shatter all substances, including the air. The answer is that three things concur to make a percussion great, the bigness, the density, and the celerity of the body moved, and of these, light has only one, namely celerity. He speaks of motes of the air which we see but cannot feel, the falling of a straw on one's head, etc., etc., and then makes an elaborate calculation to determine the density of the light of the sun.

"Then density of the light we have here on earth is to the density of that part of fire which is the sun's body, as the body of the sun is to that body, which is called Orbis Magnus (whose semidiameter is the distance between the sun and the earth) which must be in subtriple (18) proportion of the diameter of the sun to the diameter of the great Orbe."

Galileo (19) makes this one to 106,000,000, and applying Snell's computation of the relative density of flame and gunpowder, it at once appears that a grain of light at the earth must be 106,000,000 times rarer than the flame at the sun, and consequently 125,000 x 106,000,000 or 13,250,000,000,000 times rarer than gunpowder. This is full of absurdities; not to say anything of the very serious error in the ratio assumed, or of the relative density of gunpowder and flame (which might pass in the existing state of pneumatics) it should have been obvious even to Digby that he was assuming that the rarity of light was uniform throughout the half-sphere of the Great Orb, while his own method would prove that the nearer to the sun the less the rarity of light. On his hypothesis it was impossible that the rarity of light could be uniform, and this impossibility was the basis of his computation. Compared to this glaring absurdity, his assumption that the light came from the whole of the half-sphere of the sun, and not simply from the surface is as nothing, even if the mistake were not pardonable in the existing state of science.

It is obvious that the true ratio of the "rarity" of light (assuming Digby's other propostions) at the sun and at the earth is not the triplicate but the duplicate ratio, the ratio not of the cubes but of the squares, of the radii of the great orb and sun reducing the ratio to about 28,000,000,000 to one (20).

Digby, having now proved that a grain of gunpowder is 13,250,000,000 times as heavy as a "ray of light as big as a grain of gunpowder," he asks "what degree of celerity light must have, more than a grain of gunpowder, to recompense the excess of weight which is in a grain of gunpowder, above that which is in a ray of light as big as a grain of gunpowder?" He indulges in an extraordinary computation to find the ratio of the semi-diameter of the *orbis magnus* (i.e., the distance of earth from sun) to the semi-diameter of a grain of gunpowder, and taking 60 grains of gunpowder to the inch, he finds that the semi-diameter of the *orbis magnus* would contain 9,132,480,000,000 grains of gunpowder (21)—or as he says, "there will be in it but 9,132,480,000,000," and adds, "whereas the other calculation makes light to be 13,250,000,000,000 times rarer than gunpowder which is almost ten times a greater proportion than the other." This has no possible meaning. I have tried to enter Digby's mind to find out what he meant to say, or what he thought he was saying, but have failed. It is impossible that he could have had any definite meaning, and this part of his book is so much idle verbiage. He affects to be determining the speed of light as compared with the "speed of gunpowder"—whatever that may be, and what he finds is the number of grains of gunpowder which would lie upon a semi-diameter of the earth's orbit. What that has to do with the relative speed no one can tell, and what is meant by saying that one ratio is "ten times greater than the other" is a mystery. The statement is untrue, and if true could have no relevancy.

However, he thinks he has proved that the extra velocity of light does not counterbalance its extreme lightness and consequently infers that "it is impossible that a ray of light should make any sensible percussion, though it be a body" (22).

Now he turns to the last objection, viz., that light is not "fanned by the wind," as it was contended it would be if it were a body. His answer is an extraordinary bit of logomachy, and as a sample I here transcribe it:

> "As for the first part, we see that, when a body is discern'd now in one place, now in another; then it appears to be moved. And this we see happens also in light; as when the sun or a candle is carried or moves, the light thereof, in the body of the candle or sun, seems to be moved along with it. And the like is in a shining cloud or comet.
>
> But, to apply this to our purposes: We must note, that the intention of the objection is, that the light which goes from the fire to an opacous body far distant, without interruption of its continuity, should seem to be jog'd or put out of its way by the wind that crosses it. Wherein the first failing is, that the objector conceives light to send *species* to our eye from the midst of its line; whereas with a little consideration he may perceive that no light is seen by us but that which is reflected from an opacous body to our eye; so that the light he means in his objection is never seen at all. Secondly, 'tis manifest that the light which strikes our eye, strikes it in a straight line, and seems to be at the end of that straight line, wherever that is; and so can never appear to be in another place; but, the light, which we see in another place, we conceive to be another light. Which makes it again evident that the light can never appear to shake, though we should suppose that light may be seen from the middle of its line; for no part of wind or air can come into any sensible place in that middle of the line with such speed, that new light from the source doth not illuminate it sooner than it can be seen by us; wherefore it will appear to us illuminated, as being in that place; and therefore the light can never appear shaken. And lastly, it is easier for the air or wind to destroy the light than to remove it out of its place, as that we should see it in another place; but if it should remove it, it would wrap it up within itself and hide it."

Digby concludes his discussion of light by saying that "fire is the most rare of the elements and very dry .. .. that it may be cut into little pieces .. .. .. it multiplies extremely in its source; it must of necessity follow that it sends out in great multitudes little small parts into the air and other bodies circumfused with great dilation in a spherical manner . . . these parts are easily broken and new parts still following the former are still multiplied in straight lines from the place where they break . . . that it must in a manner fill all places, and no sensible place is so little but that fire will be found in it if the medium be capacious . . fire must of necessity do what experience teaches us that light doth. That is to say in one word, it will show us that fire is light. But if fire be light, then light must needs be fire. And so we leave this matter."

## SWITCHBOARDS*

By S. E. M. Henderson

I PROPOSE to divide this talk into two sections, the first part, consisting chiefly of a number of lantern slides, illustrating some of the engineering features, and the second part covering, in a general way, the commercial aspect of the work from the manufacturer's standpoint.

The term "Switchboards" is applied to a piece of control equipment that shows wide variations in structure and appearance, and which is used for a wide variety of purposes. In North America this control equipment is called "Switchboards," in Europe, "Switch gear," but neither term is truly descriptive, because, in both cases, the equipment involves not merely switching but also control, protection and measurement. This means that a great many individual pieces of apparatus and material (probably 3,000 or more) are used in making up the various kinds of Switchboards, and consequently the subject is an extensive and complicated one. The lantern slides will show only a few of the more important parts.

Coming now to the second part of the talk, we will leave the physical aspects and consider some of the commercial features. Switchboards and Switchboard Apparatus, like all other material made by our Company and other Companies, are made to be sold at a profit, with a view to paying dividends on the money invested in the business. This is the primary object, but many features of more or less importance have a bearing on the final results. So far as the general principles are concerned, selling switchboards at a profit is the same as selling generators, sugar, transportation, personal services or any other tangible or intangible asset. Numerous books on selling and salesmanship are available, giving analyses of the different steps involved in making a sale, describing the psychological processes on the part of the buyer and seller and covering the entire proceedings from all angles. Therefore, it is only necessary to cover here certain details that apply to switchboards and some other devices in particular, rather than to all commodities.

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*Paper presented before the Engineering Society on Feb. 23rd, 1921.

To begin with, orders are obtained or lost on the basis of price, quality, shipment, service, or a combination of two or more of these features. Many years ago, sales were often influenced or determined by other considerations, such as lavish entertainment, including plenty of liquid nourishment, enthusiastic misrepresentation of the apparatus and even direct or indirect bribery. To-day, however, the situation is fortunately radically different, and you will find that both sellers and buyers are doing and encouraging business on the basis of price, quality, shipment and service. This change is important and basic, because the bulk of any established manufacturer's business today involves dealing with the same customers day after day, week after week, and year after year, with a relatively small proportion coming from new customers. Hence maintaining good relations is probably even more important than developing good relations.

Having in mind the basic principles just outlined, it becomes evident that the term "commercial" as applied to business today, is a very broad one and cannot be limited to the activities of the salesmen. As a matter of fact, every individual connected with a manufacturing organization has an influence on the commercial aspects of the business.

Starting with the Designing Engineers, who generally look on themselves with pride as being purely Engineers rather than Commercial men, we find that they design the apparatus which is used to make up Switchboards. As the design is a controlling factor in determining cost and quality and an important factor as regards time required for manufacture, it is evident that the Designing Engineers are closely connected with at least three of the direct causes of making or losing a sale.

Considering the Production Department, Stores Department, Test and Inspection Department, and the factory itself as a group, we again find a very close connection with the four commercial features. This group is responsible for selecting of good materials and providing good workmanship, both of which items enter largely into the matter of quality. It is the controlling factor as to time required for shipment. Labor, being a considerable portion of the total cost of a device, the group is also directly related to the question of price. Price is also partly determined by the cost of raw materials for which the Stores Department may be responsible though, in the larger organizations, it is customary to have a separately organized Purchasing Department. None of the Departments mentioned in this group are ordinarily considered as Commercial in any sense of the term, and yet it is evident that they have a very important bearing on the Commercial success of any manufacturing organization.

A Manufacturing Company usually consists of three main divisions, the Factory, the Head Office and the District Sales Offices. The first has been considered separately already, there being relatively little overlapping between it and the other two divisions. The Head Office, of course, includes the Executive Staff, which determines the general policy of the Company and controls the finances, frequently controlling them too much, in the opinion of the employees as expressed on pay-days. The Head Office also includes a large clerical staff, the third general division being the Commercial or Sales Staff. Here we have arrived at a group that is recognized as Commercial, or primarily interested in sales. Such a staff usually includes engineers who have specialized on certain subjects such as Transformers, Switchboards, Induction Motors, etc., etc. They are used to help the Agents in making sales, to help customers in their engineering work, and to advise the Executive Staff on various commercial and engineering matters. In case of disputes with customers which involve the factory, the Head Office staff is almost sure to become an arbitrator or referee, the Designing Engineers taking the factory side of the case and the Salesman taking the customer's side. When the matter is finally settled, the Head Office representative is fairly sure of severe criticism from the losing side and feels proud of his diplomacy if he does not also get it from the Management. To properly fill a position on the Head Office Sales Staff, a man must be well posted on both Sales and Engineering work, and must do both all the time. His connection with price, quality, shipment and service is therefore a combination of that of the factory and of the District Office Sales Staff and need not be separately detailed.

A Salesman in a District Office, if he desires to succeed in selling Switchboards, should have all the regular qualifications of Salesmen in general and should also be accurate and very thorough as regards details, which is a feature commonly supposed to be almost directly opposed to certain of the inherent qualifications of a Salesman. It is necessary for him to know the construction and advantages of his own line of apparatus, and he should know that of his competitors almost as well. He should know how to apply his apparatus to his customer's conditions. As many customers have only a general knowledge of switchboards, the Agent should be able to determine not only what the engineer thinks he wants but also what he really needs.

Having determined what is required for a specific case, or at least the complete conditions of service, the Agent must be able to pass on the information, by letter and sketches, to the Departments that prepare the quotation. On receipt of this, the Agent must be able to prepare a definite, accurate and attractive proposal for the customer. This involves the ability to use correct, concise English clearly expressed. You will often find that your price is high, your shipment long and possibly your Company has been falling down a little on service. In such a case, your only chance for a sale is on the basis of quality, and you can easily lose this chance if you cannot present a good clear cut statement. Therefore, I wish to emphasize the importance of knowing how to use the English language correctly and effectively.

Salesmen can assist themselves and the commercial organization a great deal by forwarding definite and accurate information to the Head Office, concerning the competition met on any particular proposition. I have often received reports on switchboard quotations stating that our price was 10, 15 or 20 per cent. high, or even worse, only to find on careful investigation, that the low competitor had quoted on a comparatively poor arrangement of the switchboard, or an apparatus of too small capacity for the conditions, or had entirely omitted certain valuable portions of the equipment. Under such conditions, a straight price comparison is both unfair and useless, and salesmen must be careful to get actual facts if they wish to avoid the unnecessary loss of business.

A service that every salesman should give his customers and one which they greatly appreciate, is in the elimination of operating troubles, and the adjustment of complaints. To do this properly you must know the apparatus well, and must know how it should be used. The first thing to do is to assume that the apparatus as furnished is O.K. and that the local conditions are to blame for the trouble. A thorough investigation along these lines will usually identify the cause of the trouble, and if it does not, you will at least then be able to make a clear and complete report on the subject, which will enable the Engineering Department from their records and knowledge of the apparatus, to determine and correct it. The final adjustment of complaints, if fair to both parties, can only be made after a thorough investigation.

Before leaving the subject of complaints, I wish to point out that many of them may appear trivial to the Salesman, partly because of their nature and partly because he knows that the particular trouble involved occurs very seldom. However, even small troubles look big to the operating Engineer, because they are a source of discussion and worry until they are fixed. Therefore, it is most important to give the best possible service and satisfy the customer on every complaint.

There is only one other point of importance that I wish to bring out here, which is that the Salesman is the Company's only direct point of contact with customers, and they base their opinion of the Company very largely on the individuals with whom they come in direct touch. They will often overlook faults on the part of the Company, if sure that the Agent handling the matter for them is doing the best he can to protect their interests. Therefore, be sure that you are as good as your Company and its apparatus, and preferably a little better. You will find that the good personal relations resulting are an important asset.

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# THE SODA INDUSTRY *

By G. Norwood Comley,
*Manager of the Canadian Brunner Mond Co. Amherstburg, Ont.*

IT is not generally appreciated that the soda manufacture is a key industry to almost as great an extent as iron. In 1910 the iron production in the United States was 26 million tons, while soda ash was about one million tons, or one ton of soda ash for every 26 tons of iron. Even this comparison does not give a clear idea of the extent to which soda ash enters the many things which we are using daily.

It plays an important part in the manufacture of glass, paper, soap, food and medicines, water purification, textiles (washing and mercerizing), tanning, bleaching, cleansing (from laundry to metals), dyes, batteries, wood pulp, picric and carbolic acid, explosives, etc.

During the war the soda manufacturers throughout the world were supplied by Governments with men and coal without restrictions. Enlisted men, when found to be experienced soda manufacturers, were returned to their work under Government order. An interesting evidence of the importance of the soda industry to the war was shown at the Dombasle plant in France, near the border line of France and Germany. The line of battle approached to within five or six miles of this plant. The Germans tried hard to get possession of the plant, but made practically no attempt at destroying it, evidently with the hope of getting possession of it, until July, 1918. It was evident at this time to the Germans, as well as the Allies, that the German cause was hopeless. A bombardment of the plant was started, and in 48 hours they fired 500 shells into the plant. Fortunately, comparatively few of them struck and no great damage was done.

The United States uses about 20 lbs. of soda per capita per year, while Canada up to the present time uses about half that amount. Foreign countries, I believe, use a still greater amount.

Until 1880 the entire consumption of the United States and Canada was imported. At that time the Pennsylvania Salt Co. manufactured a small amount. In 1884 the Solvay Process Company was inaugurated, using the Ammonia Process, and from that time the imports to the United States rapidly decreased until

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*Address delivered to the Chemical Club in November, 1920.

1905, when the imports ceased, and a small amount was exported. In Canada the entire consumption was imported from England and the United States until September, 1919, when the Brunner, Mond, Canada, Limited, Plant was started at Amherstburg.

**History**—The real history of the soda ash industry starts about 1775. Previous to that time nearly all the soda ash of the world was obtained either from natural deposits of sesqui carbonate of soda, which is converted to soda ash by calcining, or from the ashes of sea plants. At about this time, however, the demand exceeded the supply, and the French Academy of Science offered a reward for the development of a process for the manufacture of soda from common salt. Among other contestants was Nicholas Leblanc, whose process seemed encouraging and to whom a patent was granted in 1791. He at once started manufacture on a large scale, but during the French Revolution his plant was seized, his patent declared public property without payment of indemnity to him. He was so discouraged by this loss that he committed suicide. His process has been retained to the present day with only minor changes.

The ammonia soda process reactions were discovered in 1838 by Dyar & Hemming, but no one could work it out commercially until 1863, when Ernest Solvay and his brother, Alfred, developed apparatus which would successfully operate on a commercial scale. The first plant was built at Couillet, Belgium, and from that time on the industry made enormous strides. When Mr. Solvay took out a patent and proceeded to manufacture soda ash, it is said he believed himself to be the discoverer of the reaction of the process. Had he known of the many experiments made since Dyar & Hemming's discovery in 1838, all of which proved failures, he would not have had the courage to undertake the task. His ignorance was therefore a great boon to the human race, as he attacked the problem with great energy, combined with a high degree of mechanical skill. Even then his finances almost gave out before the results were accomplished. He made many improvements in the first few years, and in 1873 he built a plant near Nancy, France, which was very successful, and since that time the process has rapidly overhauled the Leblanc process until now the latter is doomed to extinction. The only feature which has enabled it to compete with the soda ash process is the production of hydrochloric acid as a by-product, and with the development of new methods for this production the complete failure of this process is bound to ensue.

The Solvay Brothers inaugurated a broad-minded policy whereby the rights to manufacture were granted to independent organizations in each of the countries whose demands warranted a home supply. Each of these companies is entirely separate and under its own control, but there is a system of interchange by which all plants derive benefits from any new developments or improvements made in any of them. In this way the Canadian plant at Amherstburg has been developed, as an offshoot of the English firm of Brunner, Mond & Co., which has plants at Northwich, Middlewich, Sandbach and Lostock. At first there were few users of the ammonia process outside of the Solvay Companies, but there are now many in the United States and Europe. There are many countries throughout the world which are now starting up soda ash plants which have imported their entire product heretofore. China and Japan are both noticeable in this regard. It is rather interesting to know that in Japan in the majority of the plants started—there are about twenty which have been founded since 1918—there are only three which use the ammonia soda process.

**Natural Soda**—There are natural deposits of soda in a great many places throughout the world, some as nitrates, some sulphates and a very few in quite pure sodium carbonate and bicarbonate. Many of these deposits have tempted investors and a number are being exploited at present. It is generally found, however, that deposits are very far from railroads and points of consumption, and that impurities are hard to separate. The industry in this line therefore has not made rapid progress.

**The Leblanc Process**—Briefly the process is carried out as follows: Sodium chloride is treated with sulphuric acid, forming sodium sulphate or "salt cake" and hydrochloric acid. The salt cake is charged into a long reverberatory furnace, together with powdered coal and washed lime-stone or chalk, and heated to a temperature of about 1000° C. When the mass stiffens and the salt cake is all decomposed, forming soda ash, calcium sulphide and carbon dioxide, it is raked into a ball and washed with water in a series of tanks having perforated bottoms. The soda ash solution is heavy and settles in the bottom and is drawn off. This lye is settled and pumped to carbonating towers to convert any caustic soda present to carbonate. The liquor is then evaporated to dryness, the resulting product being monohydrate which in turn is calcined to remove the combined water.

**The Ammonia Process**—The reaction of the ammonia process may be expressed by the following formula:

$$NaCl + NH_3 + CO_2 + H_2O = NaHCO_3 + NH_4Cl$$

(simplest form)

The elementary process is a simple and continuous one. The ammonia gas is pumped through fresh saturated brine in the absorber. This heats up the brine and throws out impurities which are either filtered or settled out, unless the brine has been purified with lime and soda before ammoniating.

The ammoniated brine is then cooled and sent to the precipitator, where $CO_2$ is pumped through it. As the liquor comes down through the precipitator , first ammonium carbonate, then ammonium bicarbonate is formed. In the lower part of the precipitator are cooling coils which chill the liquor and throw out the bicarbonate of soda. This is then filtered off, and the bicarbonate dried and decomposed to sodium carbonate or soda ash. The filtered ammonium chloride goes to the distiller where, after mixture with lime, the ammomia is to the distiller where, cooled mixture with lime, the ammonia is distilled off, cooled and goes to fresh brine again in the absorber, thus completing the cycle.

**Raw Materials.**—Raw materials used are, of course, salt and limestons with ammonia. Coal and coke are necessary adjuncts. Salt and limestone are generally found in the same neighborhood, salt ranging anywhere from 500 to 1,500 ft. below the ground level, and stone from surface to 30 ft. down. The salt strata are from 50 to 300 ft. in depth, and salt is either obtained from mining or by means of wells drilled to the bottom of the salt strata, water being sent down to dissolve the salt. Any of the several methods of deep well drilling may be used for raising the brine—deep-well pump, or pumping water down under pressure to force the brine up, natural water pressure, or air lift system. Frequenlty in the salt strata are found shelves of rock from 3 to 6 ft. in depth. It is unfortunate when these shelves are found, as they are apt to break away after the salt is dissolved under them and damage the tubes so it is necessary to redrill the well. This may take a week or months, and a fresh cave-in may start, almost immediately after completion of the cleaning-out of the well.

**Chemical Analysis** of brine obtained varies in different localities, calcium sulphate or chloride and magnesium sulphate or chloride being the main impurities. As stated above, these impurities are thrown out, either by brine purification or in the process of ammoniation, and are therefore not particularly serious. The brine of course must be as nearly saturated as possible.

The purity of the limestone is quite important. Calcium sulphate, magnesium sulphate and silica are the main impurities. The silica forms clinker in the kiln, the magnesium uses up the fuel, and the sulphate causes trouble all along the line. Stone with 97 to 98 per cent. carbonate is always sought for the process.

**Apparatus**—Taking the apparatus in detail we have first the absorber. It consists of a tank with compartments containing umbrella-shaped distributors for the upgoing gas and overflows for the down-going liquor. If the brine has been purified beforehand, the absorber keeps clean—if not the impurities are thrown out in the absorber, and an interesting game develops. It is, of course, understood that in all cases where substances are thrown out of solution, scaling takes place, and therefore the absorber rapidly becomes fouled with scale of calcium and magnesium carbonate. The calcium comes out of solution easily and permanently, but the magnesium precipitates out and returns to solution so easily with various amounts of ammonia and temperatures that it is a nice trick to see that it send up as a precipitate, and so is removed in the filter or settler. If it goes on in solution from the absorber it gradually comes out, scales pipes and increases impurities in soda ash. It is necessary to provide spare apparatus in order to cut out the scaled apparatus at frequent intervals for cleaning.

**Precipitator**—Precipitator is also a high tank with umbrella-like distributors for the upgoing gas, but, unlike the absorber, it contains a solid mass of liquor. In the lower portion of the precipitator are cooling tubes for cooling the liquor to the proper degree for precipitation. The ammoniated brine enters near the top, coming down through the precipitator, and is drawn off the bottom with entrained bicarbonate of soda. CO2 gas from the lime kiln and from the decomposed bicarbonate is pumped into the bottom, and the remaining gas (after practically all the CO2 has been absorbed) is drawn off the top and washed with brine. A large amount of heat is evolved during the absorption of CO2, which must be removed. In the early stages of the industry this was done by flushing water over the outside of the precipitator, which was, of course, an uneconomical and inefficient method. They are now cooled as mentioned above.

From thermo chemical and other known data we find we have to deal in precipitation with a reversible action. It is therefore natural to conclude that a low temperature favoring the more complete precipitation of NaHC03, and thus carrying reaction in the direction in which we wish it to go, is most desirable. However, if too low a temperature is obtained, there is danger of separating out excessive quantities of the other three salts in solution, viz., salt, ammonium chloride, ammonium bicarbonate. Reaction therefore is stopped considerably before the decomposition of all salt, which is in effect taking advantage of the law of mass action. About 25 to 33 per cent. of the salt in the brine is therefore lost.

The three things to be desired in the precipitation process are maximum NaCl convertion, minimum precipitation of other salts in solution and a coarse grain bicarbonate which is readily filtered and washed. Here as in the other apparatus where any precipitation takes place, scale is formed which gives a considerable amount of trouble. It is, therefore, necessary to have spare apparatus in order that each precipitator may shut down in its turn and scale removed.

The mother liquor containing sodium bicarbonate in suspension is discharged from the bottom of the precipitator and flows to the vacuum filters. From the filters the wet bicarbonate is conveyed to the dryers. These are either of the oscillating or rotary type. The usual form in this country is the horizontal rotary type, similar to the cement furnace. Reaction taking place in the dryer is represented by the formulae:

$$2\ NaHCO_3 + heat = Na_2CO_3 + CO_2 + H_2O$$

$$NH_4HCO_3 + heat = NH_3 + H_2O + CO_2$$

The gas given off from the dryer should contain over 70 per cent. of $CO_2$, and after being washed to remove the ammonia is used over again (with the addition of gas from the kiln) in the precipitator.

**Bicarbonate.**—If bicarbonate of soda used for baking powders, baking sodas, etc., is desired, the wet crude bicarbonate is taken from the filters, dissolved, and recarbonated in the precipitator, the pure bicarbonate resulting. It has not been found possible to dry the crude bicarbonate sufficiently to remove the ammonia without decomposing it.

**Caustic**—If caustic soda or sodium hydrate is desired, any of several processes are used—by lime process in which the finished soda is dissolved, causticized with lime and evaporated in the various forms of evaporators and pots; or the Loewig process in which dried soda is heated with feric oxide, forming sodium ferite, which is then lixiviated and sodium hydrate and ferric oxide resulting. The finished caustic is then either packed directly in drums, forming solid caustic, or flaked by means of the flaking machines on the market, if flake caustic is desired. These flaking machines consist of plain cast iron drums, which are cooled and upon which the hot concentrated caustic is poured. The caustic is cooled and hardened on the drums, and flakes off into small chips, which are packed direct. In this process the removal of impurities and the doping of the finished caustic for color are the most interesting features.

**Ammonia Recovery**—The mother liquor from the filters containing some free ammonia and some fixed, i.e., ammonium chloride, is sent to the distiller, where it is treated with milk of lime, for decomposition of ammonium chloride, and the free ammonia distilled off by means of exhaust steam from various engines of the plant. At this point is added the crude ammonia to replace the wastage in the operation.

$$2NH_4Cl + CaO + heat = 2NH_3 + CaCl_2 + H_2O$$

The distiller consists of a tall tank similar to the absorber with umbrella-like distributors for the uprising steam and gas. The resultant liquor is calcium chloride and salt, most of which goes to waste. A small portion of it is evaporated for recovery of the salt and solid calcium chloride, the latter being used for refrigerating purposes, road manufacture, etc. The distiller, like the absorber, also scales up, due to precipitation of calcium and magnesium sulphates, and therefore requires a spare for continuous performance. The scale formation makes a very interesting study throughout the process, and is continually producing surprises.

Very slight changes in strengths of liquor temperatures or pressures will increase or retard the rapidity with which the scale forms in a most surprising manner, and even after many years of experience there is still much to be learned in this line.

Lime Kiln—The lime kiln is the source of the C02 gas used in the precipitator, also the lime used for recovery of ammonia in the distiller. The requirements for proper burning of lime in the kiln are therefore: limestone, as rich as possible in order to have as little impurity going to the distiller and as little slag formed in the kiln as possible. The kiln must have a tight top in order to obtain as rich C02 gas as possible. In this connection coke is used in order to provide rich C02, and the coke should be properly sized and as free from ash as possible. The operation must be conducted with care with just a sufficient amount of air to completely burn the coke and a sufficient amount of coke used to completely burn the limestone without overburning it. For the proper recuperation of heat the kiln should be high enough to warm the air up before reaching the fire zone and to cool the gas off at the top before leaving. The gas leaving the top is washed in order to further cool it and remove the dust.

Lime Slacker—The burned lime is slacked in either stationary tanks with agitator or in horizontal rotary tanks. The milk of lime, of course, is kept at as strong a consistency as will flow freely in order to keep down the amount of water which must be boiled up in the distiller.

**Continuous Ammonia Cycle**—As the ammonia in the process makes a complete cycle from the absorber to the precipitator, to the distributor and back to the absorber again in a fixed time, and repeats that cycle without pause, it is absolutely necessary that uniform and steady operation should be obtained. The brine enters the process at a fixed rate and passes through the system and out through the distillation exit at a steady rate if there are no interferences. If there are no interferences it is therefore easy to plan on steady strengths of brine and ammonia, temperatures, pressures, etc. It requires long experience, but it can be done if there are no interferences; and every manufacturer will tell you the secret of efficiency in the manufacture is a steady, continuous and uniform flow of material from raw to finished product.

Raw materials must be started in a proper quantity and flow through the proper channels to join each other at fixed points to be moulded into the finished product. In many industries the flow can be stopped at night and started in the morning without loss. The flow can be arranged by machinery with exact precision. In a visit to such a plant you can see one piece of metal swing into place by an automatic arm just after the previous tool leaves by means of another automatic arm. The whole process is mechanically timed and operated with no variables.

In a chemical manufacture the conditions are totally different. Pipes and apparatus scale up and solid matter settles out, thus changing velocities, pressures, cubical contents, surface areas, etc. These are anticipated when possible. But there are frequent conditions which cannot be foreseen. An old foreman used to say if we could see through cast iron we would be all right. An apparatus will frequently run along with no apparent change in conditions when of a sudden everything stops at once. Upon shutting down for examination the interior will be found in such a state of fouling that it is difficult to imagine how it had run at all for the past week or more. These conditions continually keep the business interesting by turning up at unexpected moments in unexpected places.

**Electrolyptic Caustic**—The direct production of caustic soda from salt brine by means of electric cells is a very rapidly increasing industry. Salt brine is run through the cell, NaCl decomposed and caustic hydroxide formed at the positive pole and chlorine given off at the negative pole. The chlorine gas is then run over lime to form bleaching powder.

**Various Forms of Soda**—There are many forms of soda used on the market, the simplest form, of course, being soda ash or sodium carbonate. This is used chiefly in the manufacture of soap and paper, the various soda salts, silicates, acitates, permanganates, chromates, prussiates, hypochorites, etc., enamel, water purification, tanning, etc. In the manufacture of glass, although soda ash direct can be used, it is preferable to use what is ordinary known as dense ash. This is straight soda ash densified so that the weight is about 75 per cent. greater per cubic ft. than ordinary ash.

**Bicarbonate of soda** used in baking powders, baking soda, etc., caustic soda used in soaps, paper, batteries, electroplating, mercerizing, viscose, dyes , salicylic acid (aspirin), oxalic acid and acids used in explosives—picric and carbolic.

**The modified sodas** are in many forms—soda crystals, sal sodas, mixtures of soda ash and bicarb with and without the addition of water are used in the various forms for washing, water softening, metal cleaning and woollen mills. Combination of caustic soda and soda ash generally known as causticized ash is used where a stronger alkali is desired for cleaning metals, washing bottles, etc.

**By-products of Soda Ash Industry.**—Calcium chloride is produced from the discharge liquor from the distillation and is used in connection with road building, drying, refrigerating, steel tempering, coal washing, etc., also in the manufacture of crown filler. Ordinary salt (also made from the discharge from the distillatiion in connection with calcium chloride) which of course is used for ordinary salt purposes, tanning, refrigerating, water purification, etc. Calcium carbonate in very fine form is obtained from the lime caustic process and is used as precipitated chalk, paper filler, paint and rubber fillers, tooth powder, etc.

**Ammonium Chloride** is sometimes made from liquor, leaving the precipitating column by excessive chilling.

**Outlook for Soda Industry—Conclusion.**—The consumption of soda in its various forms has fluctuated less in the past than the majority of commercial products, and there is every reason to believe that as time goes on it will be found that there is more and more constant and steady demand for the product. The consumption per capita has increased slightly more rapidly than the population in both U. S. and Canada, and it is believed that in Canada the increase is more rapid than in the States. The increasing of consumption per capita is largely a matter of education, both regarding the individual uses and manufacturing uses.

In the latter case one of the most noticeable chances for education is along the lines of metal cleaning. A few years ago comparatively no soda was used in this way, an dit was a very difficult proposition to clean metals in various manufactures as was really needed. The various shops are now very rapidly learning of the value of soda in this use, and are very greatly benefited thereby. The use in bottle washing and laundries is also very rapidly increasing.

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# NEW BUILDING FOR ELECTRICAL ENGINEERING AND APPLIED MECHANICS

SOME years ago, the Board of Governors of the University prepared an elaborate plan of possible future building extensions on University property between College and Bloor streets. Among these was a rectangular group of buildings for Applied Science, of which the Chemistry and Mining Building on College street was the south side, and the Thermodynamics Building the north side. The new building is the easterly side of this group.

Construction was approved by the Board of Governors in February, 1919, when an appropriation of $350,000 was made available for this purpose by the Ontario Government. Messrs. Darling and Pearson were engaged to prepare plans, and work was begun on the excavation work later. Construction has proceeded more or less continuously since then, with the result that the building was sufficiently advanced to permit partial occupation in September, 1920.

The building, roughly 220 ft. by 65 ft., is constructed of buff brick trimmed with sandstone, the front facing east. Throughout the entire length of each of the four floors a north-and-south corridor extends. Laboratories, lecture rooms, etc., are located on each side of the corridors. Floors are of reinforced concrete of the beam and slab type, arranged on the unit system. Nine-inch brick partitions, separating adjacent rooms, are built over the beams where required. This feature permits any large room to be sub-divided, if necessity occurs, into any lengths which are a multiple of 15 feet, 6 inches, the centre to centre distance of the girders. If two adjacent rooms are to be united, a removable brick partition can easily be taken down. There are three lecture rooms, two of which will seat about 120 students each, and one about 60 students. A library is nicely fitted for the joint accommodation of both departments. Reading comfort at tables is provided for 30 men.

Heat and electricity for light and power are provided from the University central plant. Good illumination and ventilation have been made features of the design. An elevator of three tons' capacity serves for moving apparatus to any floor in the building.

## Department of Applied Mechanics.

The main strength of materials' laboratory measures 126 ft. by 26 ft., and is located in the basement. In it have been installed the various testing machines formerly housed in the Engineering Building, viz., three Riehle machines of 200,000 lb., 100,000 lb., 20,000 lb. capacity respectively, the Olsen Torsion machine, the 30,000 lb. Buckton, the 30,000 lb. Olsen wire tester,

the 30,000 lb. Olsen column testing machine, the 5,000 lb. Riehle cross-bending machine, the Emery, and the Brinell hardness testing machine. These have been arranged roughly in two rows along the longer walls, and provision has been made in the lay-out for adding to their number as necessity may require and as funds warrant. To accommodate the large 200,000 lb. machine, a well was provided in the floor above, and into this the upper part of this machine extends. A travelling crane is to be erected which will serve every part of the machine, thus facilitating the handling of parts and testing equipment and the making of repairs. For this, the main I-beams are already in place. The well is floored over at a height of about seven feet above the floor of the lecture room immediately above, and over it the tiers of elevated seats in the lecture room have been placed. Because of this, no floor space has been sacrificed.

For the accommodation of a large capacity testing machine, the purchase of which is contemplated in the future, another well has been provided in the floor above the main testing laboratory. This well is, however, now floored over, and the space above employed for storage until such time as the new machine is installed.

The asphalt laboratory, 30 ft. by 25 ft., is equipped with all appliances necessary for conducting tests on all classes of bituminous materials. For the examination of road metals a full equipment consisting of Deval, cementation and toughness machines, has been provided.

A laboratory for cement testing, 30 ft. by 26 ft., another for experiments on the creosoting of wood, another for concrete mixing, another for small capacity testing machines, study rooms, etc., complete the facilities for work in strength of materials. The equipment is not yet all in place, but it is expected that by the opening of the Autumn term, 1921, the entire plant will be ready for use.

## Department of Electrical Engineering.

This department occupies approximately two-thirds of the working space in the building.

The two large lecture rooms referred to above are provided with all kinds of electrical services necessary for lecture demonstrations. Between these rooms is a room for storing apparatus, equally convenient for each lecture room.

The power service for the laboratories is three-wire direct current, 230-115 volts, 500 amperes capacity. Motor-generator sets provide alternating services, 60 k.v.a., 110 volts, 3 phase, 60 cycles, and 30 k.v.a., 110 volts, 3 phase, 25 cycles. The somewhat variable voltage of the direct current supply will be regulated by a booster set controlled by automatic regulators. The 60 and 25 cycle services will also be regulated automatically as to voltage and frequency. A moderate amount of storage battery capacity will also be available.

The laboratories are as follows: An alternating current machine laboratory, 106 by 26 ft., containing switchboard, service sets, local panels, various kinds of alternators, motors, converters, transformers, etc., for experimental work, with an adjoining calibration room for alternating-current instruments. A direct-current machine laboratory containing switchboard, local panels, a variety of testing sets, with adjoining calibration room for direct-current meters. An instrument laboratory, 106 by 26 ft., with switchboard and local panels, specially fitted for a large variety of electrical measurements, and an adjoining storage battery room. A radio laboratory fitted for experimental work on various phases of communication problems. Three laboratories specially fitted for study of conducting, magnetic, and dielectric materials. Four laboratories are reserved for research problems. Other rooms are fitted for special kinds of experimental studies, for electrical design, as study rooms, etc. A constant temperature standards room is located in the basement.

The three main switchboards on three floors in the building are stacked vertically to simplify the conduit work. Circuit-breakers are used almost entirely for protection instead of fuses. Each laboratory has suitable local panels for conveniently making experimental connections. Spare circuits are arranged so that any necessary connections between laboratories on any floors can easily be made.

On the roof will be erected a three-conductor aerial between masts 140 ft. apart. A single-conductor aerial 1,200 ft. long will be stretched in one span from the north mast to the tower of the Main Building on the north side of the campus.

## THE TESTING AND RESEARCH LABORATORIES OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.

By W. P. Dobson, *Laboratory Engineer.*

THE Testing and Research Department of the Hydro-Electric Power Commission was organized to supply a service which was felt to be necessary as soon as the Commission began operating its transmission system. The Commission was a large purchaser of engineering materials and apparatus, and the intelligent selection of such material and apparatus required comparative tests and thus a testing laboratory. The problems of high tension transmission necessitated continuous attention, and thus facilities for investigating electrical phenomena of high tension lines became necessary. Since a great deal of the purchasing of

An address delivered before the Electro Mechanical Club in January, 1921.

supplies by municipalities on the system is centralized in the Purchasing Department of the Commission, the testing facilities were thus of value to those municipalities. From a small beginning the department has evolved into a testing and research bureau, its functions having gradually expanded by the centralization as far as practicable of testing, research and experimental development work under the direction of this department.

### Functions.

The functions of the department are testing (including inspection) and research. In the discharge of these functions the laboratories act upon instructions received from other departments regarding specific tests, or research problems, or upon instructions respecting the undertaking of general investigations. The department may also suggest investigations and proceed with them upon receipt of approval of the suggestions.

The testing work falls into two broad groups: routine and special.

Routine testing, as the name implies, is the application of standard methods of testing to particular cases. These methods apply to many classes of engineering materials and apparatus and are usually embodied in specifications issued by engineering and testing societies. Methods have also been developed in our laboratories as a result of experience in testing.

Routine testing may be further subdivided, depending upon the purpose in view. If it is desired to select from a number of samples submitted for purchase, that most suitable, *acceptance tests* are made. Such tests are carried out in accordance with standard methods on such materials as incandescent lamps, cement, rubber gloves, etc. It is also necessary to ascertain the quality of a material after it has been placed in service. For this purpose *control tests* are made periodically on such material as transformer oil, linemen's rubber gloves, etc. A third type of routine testing consists in *standardization and calibration*, chiefly of electrical measuring instruments, the purpose being to maintain the accuracy of the laboratory instruments used in test and research work, and also of the portable standards of the meter inspectors which are used to check meters upon customers.

Special tests are those for which no standard methods have been adopted, and apply chiefly to material or apparatus of a new kind or type. In such cases, the general methods and rules of testing are used in so far as they apply, and it is usuaaly possible to obtain comparative results as between several samples submitted. Continued experience in testing the same product results finally in standard methods and in the transition from special to routine testing.

The testing work which the department has been called upon to perform has covered almost the entire range of engineering materials and apparatus. The largest volume has been heretofore electrical, but with the expansion of the Commission, problems in structural, physical and chemical testing are rapidly increasing.

Closely connected with testing is the inspection of engineering material. This is largely carried on by this department for the engineering department of the Commission.

The second main function of the laboratories is research. This is so closely allied with testing that the dividing line is difficult to distinguish. Many testing problems require investigatons which are of a somewhat general nature, and are properly classifiable as research. In the course of testing work many problems are also suggested, which give rise to research. The chief sources of research work are the engineering and operating departments of the Commission. The subjects proposed deal directly with problems in the design, construction or operation of the system. They have been heretofore largely electrical, but, as with the testing work, the range has been extended to structural and physical problems. The object of all the research work undertaken is as stated above, the solution of particular problems. No researches in pure science are undertaken, nor in any general subject unless it is evident that the results may have an immediate application to the problems of the Commission. It is, of course, to be expected that in the investigation of a particular problem, the solution of some general problem may become necessary. This may be undertaken if no solution exists, but such cases are rare. It is the writer's opinion that the investigation of general problems such as, the theory of electrical apparatus, the properties of materials, etc., is the field of the Engineering Research Schools, and that this work can be carried on conjointly with the training of men for research work.

The research work is of three types:—

(1) Theoretical.

(2) Experimental.

(3) Compilation of data.

The theoretical work consists usually in the application of mathematical analysis to specific electrical problems such as solution of high tension networks, stability and parallel operation of generators, etc. This is often carried on in conjunction with experimental investigations which form the principal portion of the research work. The preparation of general reports on various subjects at the request of other departments necessitates the compilation of data and search of engineering literature, and is thus classed as research.

All research work is carried on by co-operation among the various research men on the laboratories' staff and in other departments interested. One man is made responsible for the conduct of any investigation and the preparation of the final report of his findings. He is assisted when necessary by other members of the staff by conference or in subdividing the work. Periodical conferences are held at which particular problems and general questions are discussed.

## Organization and Equipment.

The work of the department is subdivided among several sections, as has been found most convenient in facilitating the routine work. These sections work in co-operation in this work and in the conduct of research work as has been indicated.

The equipment includes sources of power for all kinds of electrical testing, means of controlling and adjusting the same, electric circuits connecting all parts of the laboratories, standards of electrical measurement, high voltage transformers, mechanical and structural testing machines and chemical apparatus. A machine shop specially designed for delicate precision work, and a photographic section completely equipped, have also been provided.

## High Tension and General Testing Laboratory.

This section is responsible for all electrical tests except those connected with standardization, calibration and photometry. Tests on transformers, motors, generators, insulators and insulating materials are regularly made in the laboratory and in the field. The routine testing of transformer oil is an important operation which is carried on continuously. Monthly samples of oil from each 110,000 volt transformer and oil circuit breaker are sent to the laboratory and tested for dielectric strength, presence of moisture and sludging. A continuous record is thus kept of the condition of the oil in the transformers and circuit breakers, and dangerous conditions in these most important links of the system can be quickly remedied with this information at hand. The periodic testing of linemen's rubber gloves is also animportant routine test. These gloves are purchased under strict specifications and stored in the laboratories. Before being sent out each pair is given a dielectric test of 10,000 volts and sealed in a the laboratories for re-test. Every glove which punctures on a 10,000 volt test or shows excessive leakage, is discarded. The laboratories work in co-operation with the Accident Prevention Department in this work.

Many tests have been made for the Engineering Department on large generators after installation. These acceptance tests are in some cases quite elaborate, including oscillographic records of short circuits besides temperature, efficiency, dielectric tests, etc.

The research work carried on by this section is of a varied nature, ranging from simple problems on the border line between testing and research, to extensive investigations involving considerable analytical and experimental work. The following list of subjects which have been attacked or are receiving attention, though not complete, will illustrate the nature and variety of this work.

High tension insulators: A continuous investigation including methods of detecting defective insulators, causes of insulator failure, investigation of new types, etc.

Properties of iron wire as transmission line conductors.

High voltage measurement. The development of an accurate method of measuring voltage up to 300,000. A meter depending on the formation of corona for its indications has been constructed in the laboratory. Tests on this instrument indicate that it will give results of much higher accuracy than are obtainable by any other method.

The forces on busbars under short circuit conditions (theoretical and experimental). This has an important application in the design of busbars and the location of bus supports in large power stations where the generator capacity is sufficient to produce extremely heavy currents under short circuit.

High tension line calculations. Regulation, division of current among various sections of a high tension network.

High tension fuses. Short circuit tests on existing types to determine their limitations.

Compilation of data on inductive interference between power and communication lines. A report was prepared treating the theoretical, practical and legal aspects of this question.

Considerable work has been done in making tests on materials preliminary to the preparation of specifications, and in working out methods which will be of value in the routine testing.

## Approval Laboratory

In this section is carried on the testing and inspection of electrical material, devices and fittings submitted for approval in accordance with the Electrical Inspection Act, which requires that all material, devises and fittings be approved by the Commission before being sold or used in Ontario. The object of this regulation is to eliminate fire and accident hazard from electrical apparatus and appliances, and thus protect the public from dangers incident to the use of electricity by reason of defective construction. This work is similar to that carried on in the United States by the Underwriters' Laboratories.

A routine procedure has been adopted under which manufacturers submit samples of their product to the Laboratories, where they are examined and tested in accordance with standardized methods as set forth in specifications for the testing and construction of electrical appliances. When a device has been found to agree with the specifications, it is formally approved by the Commission and may be marked by the manufacturer. The Commission issues a list of approved devices and conducts an inspection service in order to be assured that approved devices are kept continuously up to standard by the manufacturers. Under this inspection service the Laboratory inspector visits the factories and examines samples taken from stock. Samples of approved devices are also purchased on the open market and examined in the laboratories.

The following partial list of devices examined and tested in the Approval Laboratory will indicate the nature of this work:

> Electrical irons, toasters, grills, air heaters, water heaters, washing machines, switches of all kinds, plug and cartridge fuses, wire and cable, motor-starting switches, ranges, fans, vibrators and massage machines, conduit, fixtures and fixture fittings, electric signs, insulating materials, farm lighting plants, etc.

This work is carried on in co-operation with the Electrical Inspection Department of the Commission, the various electrical contracting, manufacturing and jobbing associations in Ontario, and the Fire Underwriters.

### Meter and Standard Laboratory

This section conducts tests on measuring instruments and has charge of the electrical standards of the Commission. These standards consist of precision resistance, potentiometers and standard cells, which have been checked against the standards maintained by the United States Bureau of Standards at Washington. They are used to maintain the accuracy of the laboratory meters and of the meter inspectors' portable standards against which are checked the meters installed on customers' loads.

All laboratory test meters are in the custody of the meter laboratory whose duty it is to keep them in good condition. To this end a schedule has been adopted providing for periodic calibration and examination.

New types of meters appearing on the market are investigated by the meter laboratory. Considerable attention has been given to the subject of demand measurement and an extensive investigation of the performance of various types of demand meters was recently completed. The results of this work have been published. The section also co-operates with other sections in all matters relating to electrical measurement.

A considerable amount of repair work on meters is done at the request of the municipalities on the system, chiefly on watt-hour meters. A small machine shop is used for this purpose and also for the construction of special types of testing equipment for the laboratories.

The equipment includes, in addition to the standards already mentioned, a considerable number of portable meters for laboratory and field test work, galvanometers of a variety of ranges and sensitivities, condensers, inductance coils, Wheatstone bridges, etc. An oscillograph is an important item of equipment. This has been provided with accessory equipment, so that it can be readily shipped, and it has on frequent occasions been set up in power houses and sub-stations on the system, for the purpose of investigating abnormal conditions.

## Photometric Laboratory

The testing of electric lamps, lighting fixtures and illumination accessories of all kinds is carried on by this section. All lamps are purchased by the Commission under specifications which provide for rigid mechanical inspection and electrical tests. The mechanical inspection embraces such features as loose boxes, defective tips, and general care in assembly. The electrical tests consist in candle power and efficiency measurements, and life tests conducted at a constant voltage. Several standard bar photometers and an 84-inch integrating sphere photometer are used for the candle-power measurements. The life-testing equipment consists of an auto-transformer supplying by means of taps, voltages in one volt steps to a series of racks upon which the test lamps are mounted. Special means are used to keep the maximum voltage variation less than one per cent.

During the past year this section has tested many samples of automobile headlights for the Provincial Department of Highways in accordance with the requirements of the anti-glare law now in force in this Province. This law provides certain maximum and minimum candle-power values which all headlights must produce; and automobile owners must provide themselves with devices approved by the Department of Highways. This approval rests upon the test results obtained in the laboratory.

This section has also conducted extensive surveys of street illumination throughout the Province, and has designed several lighting installations of a special character. The most notable of these was the illumination of the Horseshoe Falls of Niagara on the occasion of the visit of the Prince of Wales in 1919.

## Engineering Materials Laboratory

The work of this laboratory includes the testing and inspection of structural materials. Equipment is available for tension and compression tests up to 100,000 lbs and for compression tests up to 200,000 lbs. Routine tests on steel samples, beams, cable, line hardware and many other materials are regularly made. Many special tests have been made to determine the most suitable type of material for a given use. As an example, an extensive series of tests was recently made on a number of types of supporting insulators for the busbars in the Queenston generating station. These supports were given a 10,000 lb. cantilever test, this being the estimated force upon them (having regard to a proper factor of safety) under conditions of short circuit, which would cause a current flow of many thousands of amperes.

The testing of cement forms an important part of the routine testing. From each car of cement purchased by the Commission, a sample is taken at the mill by a laboratory representative, and shipped to the laboratory. It is there tested in accordance with the standard specifications of the Commission, and the results of the tests wired to the job upon which the car is to be used. The car is accepted or rejected as a result of the tests.

Inspection of such materials as structural steel, reinforcing steel, steel transmission towers, bridges, penstocks, and other steel materials entering into the construction of power houses and transmission lines, is carried on by this section. Inspectors are sent from the laboratories to the factories to inspect the fabrication, and to the field to inspect the erection of the structures. The inspection is intermittent on small jobs, but on jobs of sufficient size and importance to warrant the expense, the inspectors follow every step in the fabrication and erection.

It will be evident from the foregoing that all material used on the works of the Commission is purchased subject to inspection. This inspection is carried on by the laboratories when the location of the material and the size of the order warrant it, and in cases of small orders placed at a distance from Toronto, arrangements are made by the laboratories with local Inspection Companies to carry on the inspection. In either case, the laboratories are responsible for the supply of materials in accordance with the specifications.

The inspection of concrete materials is also the duty of this section. This work includes all the materials entering into concrete construction and is carried on in accordance with standard instructions followed by all departments concerned. The Engineering Department designs the structure and specifies the compressive strength required. The Laboratory is then instructed to find suitable supplies of sand and stone in the neighborhood of the projected work, if possible, and to make such tests upon these materials as will determine the proportioning to produce concrete of the required strength. During the progress of the job changes in the initial proportions may be necessary as a result of non-uniformity of the sand and stone. This is provided for by placing an inspector on the job, who makes daily tests on the sand and stone and sets the proportions as a result of these tests. In order to check the quality of the concrete placed, test samples are taken from the mixer. These are sent to the laboratory and tested for compression after 28 days, or are stored on the job and tested by a portable testing machine. The introduction of this method of inspection has been of benefit in the saving of cement, as advantage can be taken, as the job progresses, of any non-uniformity in sand stone, a result not possible under the old method of fixed proportion. Its value to the designing engineer lies in the fact that he knows the strength of the structure. Without this knowledge he is forced to a more conservative design calling for higher strength in many cases than is necessary.

Considerable research work in concrete has been done by this section. The most extensive investigation has to do with methods of proportioning and is still in progress. Several publications have been issued by the Commission, giving the results of this work. Many tests have been made on concrete waterproofing and hardening preparations, quick-setting materials, and investigations of subjects connected with various features of concrete field work. A committee on concrete meets periodically and advises the various departments on all matters pertaining to the concrete work of the Commission.

## Chemical Laboratory

This laboratory is under the control of the engineering materials section. It is equipped for a considerable variety of chemical testing, and tests regularly many classes of materials purchased under specification, and much material for which specifications are not available. Lubricating oil, gasoline, paint, rust proofing compounds, galvanized hardware, are among the routine products tested. Special tests have been made on water from parts of the system, to determine its suitability for drinking purposes, or for its action on steel and copper pipes, on fire extinguishing devices, and many other types of safety devices. The engineering, purchasing, operating and accident prevention departments have been the chief sources of this work.

The work of the laboratories as described above is confined chiefly to the needs of the Commission and its municipalities. On frequent occasions, however, advantage has been taken, by the public of the testing facilities provided. Commercial tests have been made on lamps, meters, motors and other electrical apparatus. These tests have been requested both by prospective purchasers of electrical goods who wished to obtain information as to the comparative values of samples submitted to them, and by electrical manufacturers not possessing special testing equipment, who desired to know the characteristics of apparatus which they were developing. No attempt is made to compete with private testing laboratories in this work, but the absence of commercial electrical testing laboratories in Ontario has resulted in a considerable use of the laboratories of the Commission by the public.

# RESERVOIRS*

By William Gore, M.E.I.C.

THE building of reservoirs or fixed receptacles for the storage of water is a very ancient art. As soon as man began to collect in cities the need for an abundance of water as a prime necessity of life became pressing, and, while fresh-water lakes and rivers were sometimes available for the whole or part of the time, the occurrence of droughts, accompanied by the failure of crops and death by starvation, if not by thirst, made the storage of water in many cases a necessity of fixed habitation.

Unfortunately, the absence of this provision obtains in several parts of the world to-day, and death from starvation from this cause is not uncommon. The ancient Egyptians supplemented the seasonal inundations due to the spreading out of the River Nile by building reservoir dams across many of the lateral ravines or wadys which lead down to the Nile. Irrigation reservoirs are said to have been constructed in Beluchistan three to four thousand years ago, and similar works have been attributed to the ancient civilizations of Peru, India and Ceylon. In the Hebrew Scriptures references to pools and conduits appear and Noah must have had considerable skill and knowledge in the art of retaining water to have built the Ark. The art was practised under the Greeks and Romans, but, considering the high state of architecture under these people, it is a matter of astonishment that, outside a few aqueducts, very little remains to show that they understood how to retain water in large or deep reservoirs. With the exception of Portland cement and iron, the materials used by these ancient constructors were the same as those used to-day. Advantage was taken of some natural declivity, generally upon a catchment area, and the low parts dammed up by stone, compact earth and clay. Owing to water being a heavy, intrusive fluid, which, when moving, becomes highly erosive, coupled with the neglect of the necessary precautions or the difficulties in providing the proper outlet works and overflows, the failure of these early reservoirs was an almost foregone conclusion, and there are only one or two instances of ancient reservoirs remaining in use to-day.

Coming down to more recent times, the Spaniards built several large reservoirs on catchment areas for water supply and irrigation during the sixteenth century and later. Some of these are in use to-day. One very large one has failed and others have become choked with the detritus brought down by the rivers which feed them. The early Spanish reservoirs were formed by massive dams of masonry nearly as thick at the top as at the bottom, built across narrow gorges, forming horizontal arches, as well as retaining walls, which materially increased their stability.

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*An address delivered before the Civils Club in March, 1921.

Reservoir building has been carried on from the earliest times in India, and there is one instance of reservoirs being in use at the present time constructed 400 to 500 years ago. Some of the ancient Indian reservoirs—or tanks, as they are called,—covered many square miles. In the Madras Presidency alone there are said to be reservoir embankments collectively reaching 30,000 miles in length. The heights of these Indian embankments were generally limited to about 30 feet, but there is an instance of one 100 feet high, the embankment in this case being 400 feet thick at the top and 1,000 feet thick at the bottom.

The Indian embankments, after long experience, were generally safe and satisfactory, but difficulties with outlet works and insufficient provision for flood discharge has been the cause of many failures with frightful consequences. This has been particularly the case where the upper tank of a series on one river gave out, bringing the whole series to grief.

The present age is, however, essentially the age of reservoir building in all parts of the world. They exceed in magnitude anything that has gone before. The Gatun Reservoir, forming part of the Panama Canal, covers 164 square miles, and the Assuan Dam backs up the Nile for 180 miles. The depth of water retained has reached the height of the Royal Bank Building, in Toronto, walls of 300 feet in height have been constructed, and greater heights than these have been projected. The different forms of retaining walls and embankment are legion depending upon the nature of the site, the materials available and the skill or knowledge of the Engineer in charge.

The French sixty years ago developed the modern gravity cantilever masonry dam as one of the forms of retaining wall for deep storage reservoirs, and constructed an excellent example near St. Etienne.

In modern reservoir design and construction it is convenient to divide them into two classes,—storage reservoirs, generally formed by damming up a stream or river, forming the source of the water, and service reservoirs, placed on a high point near the area of distribution. The former are used to equalize the supply and the latter the demand. Owing to the number and size of the fresh-water lakes and rivers combined with the sparse population, the need for storage reservoirs in Canada is limited, but in many parts of the world they form the most important part of a waterworks or irrigation project. Storage reservoirs being frequently of vast extent, running up to many thousands of millions of gallons capacity, and costing millions of dollars to construct, they are a source of physical danger to the downstream populations and properties, and their security is a matter of prime importance.

There have been some notable reservoir failures within comparatively recent times, five of which out of hundreds stand out as catastrophes, involving the loss of over 3,000 lives and much damage to property. The cause of the failure in each case demonstrates certain necessary precautions in reservoir building, and for that reason they are briefly referred to here.

1. The failure of the Puentes Reservoir in Spain was due to improper foundations of a masonry dam constructed to form a reservoir 164 feet deep. The reservoir had been in use for 11 years, but only half filled. The first time the water rose to 154 feet the whole of the material under the dam, which consisted of water-bearing gravel, through which piles had been driven to carry the dam, blew out and discharged the whole contents of the reservoir in a very short time. The loss of life was 608 persons.

2. The Dale Dyke disaster, near Sheffield, England, arose from the failure of an earth or shale embankment, before the reservoir had been put into service. The embankment was of poor, unsuitable materials badly consolidated,. The puddle clay core was badly supported, and the outlet pipes were placed in the made ground under the embankment. Settlement of these took place, and probably some of the pipes were fractured and admitted the considerable water pressure of the reservoir into the loose materials behind the clay puddle sheeting forming the watertight layer, and the whole dam collapsed. Thus, too much care cannot be exercised in building a reservoir embankment, and the outlet works should be constructed in the form of a culvert or a tunnel in the solid, unmade ground, preferably bed rock or shale, and the outlet pipes should be within the culvert and, except at the stopping, where special precautions must be taken, should be accessible for purposes of maintenance. The loss of life is recorded as 238 persons, and a large district of Sheffield was destroyed.

3. The failure of the masonry dam of the Habra Reservoir in Algeria involved the loss of 209 lives, destroying several villages and part of a city. The reservoir was constructed in a semi-arid region upon a large catchment area, and after eight years of service, following a severe storm, covering a large portion of the catchment area, the dam must have been overtopped to the extent of probably 13 feet, which includes the height of a parapet wall. The dam was composed of very porous materials and leaked very badly. The foundation materials were also questionable, and the structure gave out, releasing about 7,000 million gallons, in addition to flood waters. Thus, in this case, the failure was due to the combined effect of inferior workmanship and materials and insufficient provision for the enormous flood discharge.

4. The Bouzey disaster in France was an example of a masonry dam constructed of poor material, in which in addition the middle third provision was not adhered to, and when the reservoir was full there was tension at the face of the dam which the masonry was too weak to withstand. The horizontal crack which formed admitted water under pressure, and the portion of the dam above the crack for a considerable length gave way by overturning. The loss of life was in the neighborborhood of 200 persons.

5. The most serious failure on record is that of an earth embankment at Johnstown, U.S.A., causing the death of over 2,000 persons and millions of dollars damage to property. The embankment was over-topped by a heavy flood, due to insufficient overflow works. The frightfulness of this disaster was much increased by the taking fire of the floating wreckage of buildings, which piled up against a bridge.

"Mexico City, Jan. 19.—More than 100 persons were drowned, and more than 200 others were injured in the disaster yesterday at Pachuoa, when two dams above the city broke and torrents of water swept through the lower sections of this big mining centre, according to the latest reports.

"A thousand persons were rendered homeless. Several mines were flooded, and it is believed the death list will be added to considerably when the shafts are cleared.

"The dams held back water used in the chemical treatment of ores, and many of the deaths were due to the victims being poisoned by swallowing this water.

"A singular feature about the disaster was that the two dams broke simultaneously. The reason for this has not been discovered."—Erindale *Engineering News*, April 14, 1910.

No reservoir of this class is absolutely watertight for various reasons, but while leakage runs clear and does not increase, experience shows there is not much danger; but should the leakage increase or become turbid it is otherwise. Thus it is usual to collect all in detail, examine and measure and keep on record all such leakages.

Every reservoir has its own peculiarity, depending upon the nature of the site which can be selected only after mature consideration, involving detailed studies of the various problems involved, often political as well as technical. Sometimes the construction of a large reservoir involves the diversion of roads, railways and canals, the displacements of populations with their schools, churches and churchyards. The geological factors covering the whole reservoir, as well as that at the dam, must receive the closest attention. It is usually necessary to sink a number of trial holes along the site of the embankment to ascertain the probable depths of the foundations or cut-off trenches.

Examples of various reservoirs are given.

Service reservoirs for water supplies being generally close to populated areas, are frequently covered to prevent contamination from various sources, such as algae growths, wind-borne materials, aquatic birds, mice, frogs, and other reptiles; suicides, the ends of the careers of unwanted dogs and cats and deliberate urinal and faecal contamination. Thus an open service reservoir can be conducted only in select neighborhoods, and where there is plenty of water surface to form a counter attraction. In the construction of these reservoirs there is no essential difference between them and storage reservoirs. They are, however, much smaller; generally the ground is less favorable, and a clean bottom and sides are desirable. The simplest kind of service reservoir is a hole dug in level or sloping ground, and the suitable materials piled in the work of an embankment around the boundary. The inner slopes of the embankment are protected by stones or concrete, and all other parts grass-sown. Of such is the Rose Hill Reservoir used by this city. Another of the same type is the Oswestry Reservoir in Wales on the Vyrnwy Aqueduct, immediately above filters. This example has the advantage of an outlet culvert, which is wanting in the Rose Hill Reservoir.

The size of service reservoir needed by a city must depend largely on the source of the water. If the water is derived from a long distance three days' supply is essential, and a week's supply is not too much. Even where the source is at hand like that of Toronto, a service reservoir is very desirable to help the pumping machinery, and filters over peaks and casualties. The maximum day's demand of Toronto in 1919 is shown (Slide 41). During that one day 18,600,000 gallons were consumed in 16 hours in excess of the average demand for the year. This was partly made up by increased pumping, but the actual demand on Rose Hill Reservoir amounted to eight and one-third million gallons, and ———— from the pure water reservoir at the Island, only part of which could be replaced during the following night. Thus a continuance of a similar demand for several days at this rate would soon have produced a shortage of the supply.

The floor of a service reservoir is frequently protected by concrete, and the embankments by concrete slabs or stone pitching. Frequently the embanking is held up by retaining walls of concrete, sometimes brick-faced. Reinforced concrete has also been used of late years for service reservoir walls. Sometimes both the floor and walls are supported and backed by puddled clay. The reservoirs may be of any plan,—circular, square, polygonal or of special shape to suit the ground. When a reservoir is covered, the roof acts in such a way as to support the boundary wall against the thrust of the earth embankment. The Toronto Island service reservoir is typical of the covered reservoirs of North America. The groined roof is covered with earth to protect from frost. The roofing in this reservoir is built on the umbrella plan, each column acting as the support to a square of the roof of 13 feet sides. Most service reservoirs leak to a certain extent, principally at cracks or construction joints. This phase would be much worse were it not for the fact that submersed concrete expands considerably, the effect being much more important than temperature effects. In order to get away from the inevitable leakage from concrete reservoir linings, various attempts have been made to use bitumen linings with some success. One of the latest important service reservoirs of this class is the Cross Hill Reservoir for Birkenhead, which appears to be absolutely watertight. The floor is wholly covered with bitumen, and there is a layer of the same material between an inner facing of brickwork and an outfacing of concrete. The walls consist of a series of horizontal arches between counterforts of steel cased in concrete and brickwork. The roof is covered by domes on an hexagonal plan, each hexagon being 30 feet across the flats. The columns are of concrete blocks. This reservoir has a capacity of 31,000,000 gallons, and is 28 feet deep. It forms part of a new supply to be derived from North Wales.

The last slide shows the Norton Tower which forms a balancing tank on the Vyrnwy Aqueduct supplying Liverpool. This is probably the most elaborate example of a raised reservoir in the world. The water surface is 110 feet above the ground, the tank is 80 feet diameter, and 31 feet deep in the centre, and holds 650,000 gallons. The bottom of the tank is an inverted dome of steel suspended from a compression ring on rollers; at the outer boundary the upper parallel portion of the tank is of cast ornamental iron. The masonry of the tower is ashlar throughout, the stones weighing from two to seven tons.

## Table of Storage Reservoirs

| Name | Date of Completion | Date of Failure | Depth of Water Feet | Height of Dam Feet | Type | Lives Lost | Yield Million Gal. per Day | Storage Millions Gallons |
|---|---|---|---|---|---|---|---|---|
| Furens | 1866 | — | 164 | 184 | Masonry | — | 9 | 330 |
| Puentes | 1790 | 1802 | 164 |  | Masonry | 608 | — | — |
| Dale Dyke | — | 1864 | — | 95 | Earth | 238 | — | 712 |
| Habra | 1873 | 1881 | — | — | Masonry | 209 | — | 6,400 |
| Bouzey | 1881 | 1895 | 49 | 72 | Masonry | 200 | — | 1,500 |
| Johnstown | — | 1889 | 70 | — | Earth | 2,000 | — | — |
| Todmorden | 1900 | — | 78 | 111 | Earth | — | 1 | 130 |
| Vyrnwy | 1890 | — | 84 | 125 | Masonry | — | 54 | 12,000 |
| Taf Teehan | In course of const. |  | 90 | 100 | Earth | — | 21 | 3,500 |
| Charme | 1904 | — | — | — | Earth | — | — | — |
| Assuan | 1903-1910 | — | 72 | 112 | Masonry | — | — | 450,000 |
| Mouche | 1890 | — | 95 | — | Masonry | — | — | 2,000 |
| Urft | 1904 | — | 166 | 191 | Masonry | — | — | 12,000 |
| Craig Goch | 1905 | — | 135 | — | Masonry | — | — | 2,000 |
| Alwen | 1920 | — | 90 | — | Concrete | — | 11 | 3,200 |
| Upper Neuadd | 1900 | — | 80 | 130 | Masonry | — | 2 | 345 |
| Croton | 1907 | — | 185 | 297 | Masonry | — | — | 30,000 |
| Eschape | 1898 | — | 116 | 120 | Masonry | — | — | 200 |
| Londenon | 1904 | — | 107 | 123 | Masonry | — | — | 85 |
| Oswestry | 1892 | — | 16 | 25 | Earth | — | — | 46 |
| Roosevelt | 1911 | — | 220 | 284 | Concrete | — | — | 420,000 |
| Pathfinder | 1910 | — | 90 | 210 | Concrete | — | — | 327,000 |
| Shoshone | 1910 | — | 233 | 305 | Concrete | — | — | 149,000 |
| Ashokan | ..1917 | — | 130 | 220 | Concrete | — | 500 | 127,000 |

## RESEARCH WORK ON CURRENT TRANSFORMERS *

By C. Kent Duff, *Research Assistant.*

THE current transformer is a piece of accessory apparatus used in connection with measurements in alternating current power circuits. Its functions are two, namely, to supply the meters with a current which is at all times a constant fraction and an exact miniature of the line current, and also to insulate the meter circuit from the line which may be at dangerously high potential. Actually the current transformer does not supply the meters with a current which is exactly proportional to the line current, because of inherent errors which cannot be wholly avoided. In the case of meters used for measuring large quantities of power for which correspondingly large charges are made, a small percentage error in the current transformer may involve no inconsiderable amount of money, and hence it is desirable to reduce the errors to a minimum.

*Presented before the Electrical and Mechinical Club on December 1st, 1920.

The general principles of operation of the current transformer and the chief factors affecting its errors are fairly well understood, but there are still some points on which our knowledge is quite imperfect. This research work was undertaken with the object of clearing up some of these obscurities. A better understanding of the principles of operation may be expected to ultimately result in better design and more intelligent use of the apparatus.

For the benefit of those to whom the current transformer is unfamiliar a brief description of its construction and a simple explanation of its operation may be made. There are three principal parts to every current transformer, a primary winding, secondary winding and a closed iron core through which both windings pass. In the so-called through-type current transformer the primary winding is not provided by the manufacturer, but a hole is left in the case through which a cable, busbar or other conductor can be passed one or more times to act as a primary. The primary winding is well insulated from the secondary and core and the secondary circuit is grounded at one point in order to keep it at a safe potential. One or more meters, relays or other current-operated devices may be connected in the secondary circuit, all being connected in series, so that the same current passes through each one. The term secondary burden, is used in reference to the constants of the part of the secondary circuit external to the transformer.

The operation of the current transformer may be explained as follows: The current in the primary winding which is connected in series with the line in which the current is to be measured, exerts a magnetizing force which causes alternating magnetic flux in the core. This flux which also passes through the secondary coil induces a voltage in the secondary which causes current to flow in the secondary circuit. This current is almost equal to the primary current multiplied by the ratio of primary to secondary turns, but is never quite so great, because then the secondary magnetizing force would be equal and opposite to that of the primary, which would leave no resultant magnetizing force to magnetize the core. The difference between the primary and secondary ampere-turns, i.e., the exciting ampere-turns are necessary in order to produce the flux in the core. It is this exciting current which causes the errors of the current transformer, and since the exciting current is determined by the core flux, any factors which affect the core flux will influence the errors.

The most important factor which influences the core flux is the impedance of the secondary circuit, which includes both the internal resistance and reactance of the secondary winding and also that of the burden. The secondary voltage necessary to force a given current through the secondary circuit varies directly as the total secondary impedance, and hence the flux which causes that voltage varies directly as the total impedance of the secondary circuit. It is, therefore, desirable to keep the secondary burden down to a minimum and not to connect more instruments in the circuit than are recommended by the manufacturer.

Another factor which very greatly influences the core flux, and thereby the exciting current and the errors, is one which has been heretofore largely overlooked. That is the effect of leakage flux, i.e., flux which, due to the strong opposing forces of the two windings "leaks" out of the core and passes through the space between the windings. This subject has been extensively studied in connection with this research work, and constitutes the main feature in the results.

Secondary leakage flux causes secondary leakage reactance, which affects the value of the total secondary impedance, and thereby influences the errors. Moreover, the value of this leakage reactance in many cases is found to exceed the internal resistance, and in some instances even eclipses the burden itself in magnitude and importance. Nevertheless, due to lack of information on this subject, many designs and attempted calculations of performance are made without any consideration of leakage reactance.

Other facts in regard to leakage flux which have never been noticed hitherto have been brought out by this investigation. The quantity of leakage flux in the core varies greatly from point to point, due to the "leakage" which is going on. Its distribution over the core cross-section is also far from uniform, and the direction of the path of the leakage fluxes in the core varies from point to point, and seldom runs parallel to the core axis, which is the normal direction of core flux. On top of this variable leakage flux we have superposed the working flux which is practically uniformly distributed throughout the core. The combination of all these fluxes determines the exciting current, which is naturally found to be quite different from that calculated on the usual assumption of a uniform flux distribution. That the observed difference is really due to the effect of the leakage fluxes in the core was proved by constructing a current transformer in which the leakage reactance was reduced to a minimum and leakage fluxes kept out of the core. The results show conclusively that the leakage fluxes have a marked effect on the errors.

A complete report of these investigations will shortly appear in the Bulletin of the School of Engineering Research.

# ENGINEER—HUMAN FACTOR *

By WILLS MACLACHLAN, *Electrical Engineer, Toronto, Ont.*

ON the walls of the Engineering Societies Building Library, New York City, is found the following definition:

> "Engineering—the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race."

From this definition you will see that engineering has two sides—one technical detail information of the forces and materials of nature—the other the psychological information used in organizing and directing men. In your course of studies at the University, you are giving primarily attention to knowledge of the technical details of the materials and knowledge of the forces of nature. To a limited extent you have the opportunity in your societies, clubs and teams in the University of obtaining a knowledge of organization and the faculty of directing men.

After you graduate, I feel that it is very essential to obtain practical experience in engineering work in the field before you attempt to carry out the principles that you are studying in what might be called an office position. Practical experience will give you intimate knowledge of the processes of manufacture and construction, and it will also give you an insight into that most important factor in an Engineer's training, viz: the study of human nature. One point that must be learned is to respect other men's station in life. Some, possibly have not the ability that you have, and a great many others, although possessing the potential ability, have not had the opportunity of carrying on their studies, but have had to leave school at an early age and go right into life's work. Your course as an Engineer will be made considerably easier if you make up your mind to always respect the station of any man, whether holding a position higher or lower than your own. Practical experience will always give you the opportunity of studying various forms of business organization without which it would be impossible to carry on business as we find it to-day.

Fifty or one hundred years ago, factories and business organizations were of comparatively small type. The touch between employer and employed was intimate, in many cases the employer working at the bench along with his workmen and apprentices. At that time the steam engine was just coming into the industrial field, electrical motors were not known and compared with present-day machinery, the speed was very slow. With the small plant it was found that living conditions were not nearly as crowded as we find them to-day. Our huge manufacturing centres were not in existence, and men lived a far more normal life. In the growth of plants, the speeding-up of machinery, the enlargement of organization and the strain of present-day business, we find that upon workmen and executives there is a constant strain that was unknown 50 or 100 years ago.

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*Presented before a meeting of the Mechanical and Electrical Club on January 24th, 1921.

Growing out of this condition there has recently developed in industry an effort to solve for present-day conditions, a number of problems, some of which did not exist in the earlier types of factory and some of which were easily solved due to the intimate touch between employer and employed. The question of the prevention of accidents has received possibly more attention in the last five years than in any previous five years. The State has ruled that industry must assume the costs of accidents in the industry and, leaving the humanitarian element out for the present, it has been found good, sound business to institute accident prevention organization into the industry, and in this way save costs of the accidents, as well as prevent disorganization of staff due to accidents. It has also been found that the doctor and nurse, by giving their attention to industrial problems, can be of very considerable assistance to industry. The average industry losses possibly one and one-half days per employee per year due to accidents, but it loses about seven and one-half days per employee per year due to sickness. The activities of the medical staff, therefore, have been very helpful in reducing this loss. They have also been a very important factor in establishing the intimate touch between employer and employed, which existed in the smaller organization. Quite recently, matters of labor turnover were receiving the attention of executives; for instance before the war the U.S. Steel Corporation found that it cost them approximately $40 to hire and fire a common laborer. In a large organization employing and discharging a number of men, you can readily see the leaks that should be stopped. It is often found that a man employed for one position will not make out very well, but when moved to another position in the same organization will carry on successfully. The question of promotion in a large organization also has to receive very careful attention, or some men will receive possibly more than their due share of recognition, while other men will not have justice done to them. These items lead, naturally to centralized employment, job analysis and the placement of men, a matter that is receiving more and more attention as time goes on. Men who are not employed in an industry are to a very large extent raw material. Coming into a large organization, men have to be trained; even for skilled workmen it is necessary to train them into the particular processes that that organization is carrying on, and for young boys apprenticeship courses are receiving more and more attention. It is hoped that some day a more general application of the idea of Engineering Apprenticeship Courses will be given consideration. It is hardly necessary for me to point out that these various industrial relations in industry have to be correlated, and there has developed the work of the Industrial Relations Department having charge of these items, together with a number of others that I have not time to discuss.

In a very large organization, it has been found to be of at least an advantage to have some organized contact with the employees; this is commonly called "Employees' Representation," and two general plans are followed. One known as the Whitley Plan is commonly in use in Great Britain, being developed a few years ago by a committee of the House of Commons under the Chairmanship of Mr. Whitley. In a given industry, a committee is organized half representative of the employers' organizations, and half representative of Trade Unions in that particular industry. This committee represents to the Government the industry and is dealt with by the Government. Under this Committee there are District Councils and in a particular workshop, a Shop Committee, the basis of representation being in all cases representatives of the Association of Employers on one side and representatives of Trade Unions in the industry on the other. The only example of the Whitley Plan in effect in Canada is in the Building Trades.

Another plan known quite generally is the International Harvester Plan, and is comparable to the Works Committee of the Whitley Plan with the exception that the Works Council is composed half from representatives of the management and half from elected representatives of the employees of the plant, without any reference to whether or not they are members of unions or non-union members.

The plan of representation of employees has been put into effect in a number of plants. Matters that come up for discussion vary, but in general wages, hours of work and working conditions are discussed and a policy worked out; usually the execution of this policy is left with the management. Any one of you would do well to study the question of employees' representation as, at the present time it looks as if it would became very general.

I must apologize for the hasty way in which I have dealt with a number of subjects, any one of which would deserve very careful and serious consideration.

It is every citizen's duty to take an interest in the work of his country and in the Government of it, otherwise he can hardly be called a free man, if he does not execute the franchise and the liberties that have been gained for him in days gone by. You who have the opportunity of becoming professional men have added to your responsibility as a citizen an even greater responsibility in that others who have not the opportunity that you have, are, through their taxes helping to pay for your education. It is therefore, only to be expected that you will take a far greater interest in public affairs and lend your influence to develop your country in logical and sound ways, which ideas, I am sorry to say, have not been given the consideration by engineers in the past that they should have.

In closing, I would like to leave just two thoughts with you:

1.—Be an Engineer, do not be only a technician.

2.—Know men as well as things.

If you can talk with crowds and keep your virtue,
  Or walk with kings—nor lose the common touch.
If neither foes or loving friends can hurt you,
  If all men count with you but none too much;
If you can fill the unforgiving minute,
  With sixty seconds' worth of distance run—
Yours is the earth and everything that's in it,
  And—which is more—you'll be a man, my son.

## TOOTHED GEARS

By Chester B. Hamilton, Jr., B.A., Sc., M.E., '06, S.P.S.

THE subject of toothed gears is so complicated and so many-sided that it is difficult to take a comprehensive view of the matter unless some definite and orderly scheme is adopted in the first place. For our present purposes we will consider gears according to the different methods by which they may be classified.

First let us consider gears according to the material of which they are made. This may be non-metallic, or metallic of non-ferrous nature or ferrous, the latter either cast or wrought. All gears were originally made of wood, and we see a survival of this in the mortice wheels with inserted wooden cogs which have until recent years been good practice for water-wheel and similar mill drives. The cogs were of hard maple boiled in tallow. The modern practice is to use metallic gears in all such cases and confine non-metallic material to such applications as the rawhide pinions used for obtaining silent operation at high speeds on electric motor and similar drives. Fibre is also used to some small extent, but is not a good gear material on account of its weakness. Bakelite, under various trade names such as Micrada and Celeron, is an excellent gear material, particularly for wet or oily locations where rawhide would be somewhat at a handicap.

The non-ferrous metallic gears are practically always bronze except in quite small work, where brass with its cheaper price and free cutting qualities is desirable. For any job where the power transmitted or the durability of the drive is seriously considered, it pays to use bronze of a good grade, because its strength is greater proportionally than the price increase over brass. The most commonly used formula for gear bronze is 88 per cent. copper, ten per cent. tin, two per cent. zinc. For worm gears phosphor bronze of the following proportions is frequently used, and is a very high grade and satisfactory material: 89 per cent. copper, 11 per cent. tin, .01 to 03. phospor and not over .05 lead or zinc.

The cast ferrous materials are cast iron and semi steel, both made in the ordinary foundry cupola, and steel castings which may be made by the open hearth or electric furnace process. The Bessemer or Tropenas converter process is not considered to produce good enough castings for gear work. The most suitable material for steel castings is about .25 per cent. carbon with low phosphorus and sulphur. The wrought ferrous material is steel only, as wrought iron is not a suitable gear material. Both the ordinary carbon and the alloy steels containing nickel, chrome, etc., are used. The latter are always heat treated, as their full value is not obtained otherwise. There are two forms of heat treatment, for which different grades of steel are required. A low carbon steel of .10 to .25 per cent. carbon may be used for case hardening, or a higher carbon steel, in the neighborhood of .45 per cent. for hardening direct from the fire by quenching.

As the purpose of gearing is to transmit power and motion between shafts it is evident that a classification of gears according to the relaxation of their axes will be a basic classification.

Gears with shafts parallel are spur or helical gears, according as the teeth are straight or laid out on helical curves on the pitch cylinder.

Gears with shafts at an angle, but lying in the same plane, are bevel gears, and their pitch surfaces are cones whose apicies coincide at the point of intersection of the two axes. The teeth of these gears are usually straight and laid out on converging lines towards the cone centre, but they may also be curves developed on the pitch cone surface.

Gears with shafts at an angle but in different planes are commonly called either spiral or worm gears. The word spiral in this case is, however, a misnomer, as the teeth are helical. A pair of helical gears are both cylindrical and, their teeth being made up of convex curves, and their axes at an angle, there is only point contact between their tooth surfaces. A worm and worm gear pair of usual form comprise one cylindrical member, the worm, and one with concave face. Thus the gear embraces the worm around part of the circle, and therefore instead of point contact there is line contact between the teeth-like spur gears and greatly increased load-bearing ability. In the special case of the Hindley or Hour-glass type of worm, both worm and gear embrace each other, and in this case instead of line contact we find surface contact over an area of tooth face.

Gears may be classified according to the method by which the teeth are produced. Without going into details beyond the scope of this article the methods may be listed as follows: (*a*) Teeth made separately and set in mortices in the gear rim. (*b*) Teeth cast in the foundry, being moulded the same as the body of the gear. (*c*) Teeth machine cut from turned gear blank. (*d*) Teeth rolled into the rim of the gear at a forging heat by rolling the job with a toothed master gear. (*e*) Teeth may be ground to finished shape, usually after being roughly cast. (*f*) Teeth may be stamped in a punch press from sheet metal as clock gears are made or drawn through a die as pinion wire.

Another classification of gears is according to the form of the tooth. Very early gears had merely a round pin or peg. This was followed by the cycloidal tooth form which is now obsolete. Next came tooth forms based on a circular arc or two portions of arcs of different radii. This in turn was displaced by the modern involute tooth curve, which is in practically universal use to-day in one or other of its two forms, (*a*) the true theoretical involute and (*b*) the empirical modification first developed by Brown & Sharpe.

Tooth forms also vary in two other ways as well as kind of curve, namely, (*a*) in pressure angle, usually 14½ deg. or 20 deg., and (*b*) in ratio of thickness to depth of tooth, that is, whether the tooth is standard depth or of stub form.

Again, gear teeth may be classified according to the method, tool and machine used in producing the tooth curve. This applies exclusively to cut gears. (*a*) The first method is the use of a formed tool, which may be either a disc form milling cutter, or an end milling cutter, or a formed planing tool for straight line action as a planer or a broach. (*b*) The second method is the use of a formed template which controls the motion of a tool which itself is not formed, but describes by its motion the required curve on the job as it is fed into the cut. Machines based on this principle are made for both spur and bevel gears. The former have motion along the straight line elements of a cylinder, and the latter along the straight line elements of a cone.

(*c*) The third method uses neither formed tool nor template, but generates the tooth curve mechanically from the motion of the machine. This class includes the Gleason bevel gear generators and the hobbing and planing types of generating gear cutters for spur and helical gears.

The applications of gears to the transmission of power may be classified according to the requirements of the service under the following divisions, (*a*) very light service,—to transmit motion only,—as in clocks, meters and models; (*b*) rough, slow service—to transmit load at negligible velocity,—as hand-operated winches, some slow feed motions, etc. (*c*) to transmit load with a velocity factor—this constitutes the general run of gear applications; (*d*) to transmit load with velocity and also with an allowance for shocks.

Another method of classifying gears according to service is based on the quality of the requirements as to accuracy. The following classification is from the standards of the American Gear Manufacturers' Association: (*a*) Precision gears for aircraft and printing machines; (*b*) automobile and machine tool grade of quality; (*c*) standard jobbing gears for pumps, hoisting and general industrial gearing.

In the brief space available it has not been possible to go into technical details on this subject, nor give the specific information which would otherwise have been desirable. If any of the readers of this paper are interested in gear application to the extent of desiring further information, the same is available in printed form in the engineering data sheets published by the Hamilton Gear and Machine Company, Toronto, of which company the writer is President and Engineer. These will be mailed to anyone who will state the phase of gear work he is interested in. This is not advertising, but technical data.

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## STRUCTURAL ENGINEERING AS A SPECIALTY

By C. R. Young

*Associate Professor of Structural Engineering, University of Toronto.*

ENQUIRIES are frequently made by young men, both in and out of college, concerning the prospects offered in the special field of structural engineering, and the nature of the work encountered therein. So ramifying are the activities of the structural engineer, that it is not remarkable that knowledge of the real character of his work is less general than, perhaps, of any other well-established engineering specialty. To the end that those interested may be guided to some extent in any decisions they may make in the matter of entering this field, the character of the work done by the structural engineer, the personal qualifications required and the prospects offered are briefly set forth in what follows. It is not the intention either to influence hesitating persons to enter upon such work or to avoid it, but merely to sketch the present and probable future status of structural engineering.

### Many Contacts of Structural Engineering.

Structural engineering has not that narrow significance which is commonly attached to it by the layman. Familiarity with structural steel, arising from the widespread use of that material in building construction, has frequently led the public to regard the structural engineer as one whose duties have to do solely with the design of the steel-work for buildings. On the contrary, structural engineering, properly speaking, comprises the design, construction and investigation in so far as strength, rigidity, and economy are concerned, of all load-bearing structures in all practicable materials. Works, in the planning and execution of which structural considerations are of basic importance, are surprisingly numerous. They include, for example, bridges, buildings for all purposes, foundations, culverts, piers, abutments, retaining walls, sea-walls, docks, landing stages, elevated railways, subways, tunnels, tanks, reservoirs, standpipes, gas-holders, transmission line towers, wireless towers, dams, pipe-lines, flumes, penstocks, sewers, conduits, locks, lock-gates, grain elevators, headworks for mines, ships, cranes, crane runways, cableways and chimneys.

## Resourcefulness Essential

The broadly-trained structural engineer should be equally proficient in the use of steel, iron, concrete, stone, timber, brick, tile and all other materials which experience may show to be adapted to the purposes of the construction in hand. He should be able to use whatever materials are available for the construction of emergency works, as, for example, a firm of eminent consulting engineers once did in the rapid construction of a hemp rope suspension bridge to carry an important water main across a wide and turbulent river after the regular bridge had been carried out by flood. In the tropics, the well-grounded structural engineer should be able at short notice to erect bridges and buildings from bamboo and lashings, if more suitable materials are not at hand.

From the above partial enumeration of the many types of work to which the application of structural knowledge and skill is required, it is evident that the work of the structural engineer cuts across the lines usually prescribed for the engineer in charge of railway, highway, harbor, sanitary, hydraulic, mechanical, electrical and mining work, quite as much as across those laid down for the architect. No one of these practitioners can carry on his work without in some measure requiring structural services, whether supplied by an outsider, by himself, or by some member or members of his staff.

## What Does the Field Offer?

But although the necessity for applying structural knowledge and experience to the solution of innumerable constructional problems may exist, what has the field of structural engineering to offer those who enter it? What are the chances of remunerative and continuous employment, and what is the opportunity for rising to positions of increased responsibility and prestige? What is there lying beyond or outside this field to which a trained structural engineer might gain access, and in which success might be won? To what extent does work in this sphere admit of taking a progressive part in public affairs, or facilitate the development of good citizenship?

## Getting a Job.

Recent experience indicates that it should not be difficult in times of reasonable constructional activity for a young man with some structural training to obtain employment in this field. Those in charge of employment bureaux for engineers have usually found it difficult to fill all enquiries for structural men, coming, as they do, from employers engaged in a wide range of work, which may, in many cases, involve structural problems only incidentally. The companies fabricating structural steel work for bridges, buildings and the like are usually in the market for draughtsmen at the outset of the constructional season. Engineering and contracting companies employ many technically-trained men on design and supervision of construction. Municipalities and consulting engineers require designers, draughtsmen and inspectors on a great variety of work, portions of which are of a structural character, and manufacturers frequently aim to have some one in their employ who can design and carry out extensions without the necessity for employing a special outside engineer. It may, therefore, be stated that under normal conditions, constructionally speaking, there should be a good demand for men to fill structural positions. The beginner must, at the start, however, expect neither remarkable salary nor commanding position, but merely the opportunity to exhibit his capacity for getting on in the work. Tracing, making blue-prints, testing rivets or counting sacks of cement may not appeal to the young graduate as a finality, but by these lowly routes many outstanding figures in the engineering world have attained the places they now occupy.

## Relative Compensation

Whatever may be said of the relation at present existing between the compensation of engineers and the services rendered by them, it will be generally admitted that the structural engineer is no worse off than the specialist in any other branch. In fact, subordinate positions in this field have hitherto been offered salaries at least as good as, and often better than, those attached to corresponding positions in other branches. In one instance, known to the writer, a large manufacturing company paid salaries to structural draughtsmen considerably in excess of those paid to mechanical draughtsmen employed in the same room, although the latter were required to possess qualifications quite as high as those possessed by their more highly-paid associates. Of course, here, as in every other department of human activity, remuneration is a function of the demand for one's services. Generally speaking, up to the present, the demand for men with structural training and experience has been in excess of the supply. With any marked reduction of construction operations, this relation might be reversed, but if the material development of the country is to proceed at any thing like the rate maintained for the past decade or two, the man who is able to design structures and carry them to completion in the materials which he finds to hand is not likely to find his service a drug in the market.

### Continuity of Employment.

Regularity of employment is an important factor with those with responsibilities and homes to maintain. Except in times of general depression, which seriously affect all branches of engineering through the suspension of all work except that of the most immediate necessity, structural operations in office and field are quite as constant as those incident to any other type of engineering work. While the severity of our climate precludes the conduct of much outside work in winter, judicious employers will not suffer an organization to go to pieces through the loss of competent and trusted men, so that if the field engineer's particular duties all but disappear with the advent of cold weather, work is found for him in the office till the next construction season opens. Inside men in the employ of large contracting or construction companies, or in the offices of prosperous consulting engineers or architects, enjoy a continuity of work comparable with similar men engaged in business of other kinds. The incompetents will be allowed to go, and the good men will be tided over the dull periods.

### Opportunities for Advancement

Qualifications of such high order are required of the thoroughly competent structural engineer that his value in an organization naturally brings promotion, often to broader fields of work. This creates opportunity for advancement in all the grades below. The designer, estimator, checker and draughtsman all move up one step. If to be in the outside organization, the superintendent may become manager of construction and the inspector may become superintendent. A young man with a thorough structural training and sound business sense is very likely to go far in the construction industry. Great construction organizations, both public and private, are always in search of men who possess both technical and administrative capacity to take responsible executive or managerial positions, and when such men are found, advancement is the natural outcome.

### Private Practice

For those structural engineers whose experience and attainments are such as to place them in the front rank, there is some opportunity in private practice. It frequently happens that an organization or municipality requires the services of structural specialists on a specific piece of work extending over a limited period. Rather than attempt to build up an engineering organization of its own to be broken up in a comparatively short time, it delegates the work to a private firm of engineers, with resulting economy and expeditiousness. Where many cases of this sort arise in a community, the foundation for a successful private practice is created. It should be pointed out, however, that there is a growing tendency for organizations to carry their own structural engineers as permanent officials, or, if not, to seek "free" engineering services through asking contracting companies to submit complete designs as well as tenders. This latter practice very much cuts into what was formerly the field of the consulting structural engineer, particularly on highway bridge and building work. The client has so far failed to understand that he cannot get something for nothing, and that leaving everything to the contractor without adequate check, is a dangerous procedure. The tendency for governments and commissions to furnish free engineering services, as in the issuance of standard bridge plans, also interferes, to some extent, with the field of the private practitioner. Nevertheless, there are many problems which require special treatment, investigation and study, and here the private expert, if he be in truth an expert, will often find a demand for his services. Disagreeable though it may often be, court work offers legitimate employment for a structural engineer of experience and prestige—one who can with certainty state whether a piece of construction is good or bad.

## Getting Into Business

Those young structural engineers who have a taste for outdoor life and some capacity for business, who know values and can get things done, very frequently find contracting attractive. It offers an opportunity of utilizing to advantage, at one and the same time, hard-won technical attainments and the instinct of the trader. For one who is well equipped with both, this field frequently offers large financial rewards, and for this reason, no doubt, very many men attempt to enter it. Success here is, however, no more certain than in any other field, and very many contractors, failing to establish a profitable business, revert to pure engineering, for which they find themselves, after all, better fitted. While technical knowledge may be of very great assistance to the head of a construction organization, it should be remembered that contracting is a highly specialized business undertaking. The one who can assemble an organization of technical workers and so direct it as to carry out smoothly and accurately a projected enterprise is the one most likely to attain success in contracting, whether he personally is a technically-trained man or not. In general, structural training is invaluable to a contractor, for it is the carrying out to the letter of the designer's plans in concrete, steel, timber and the like, with which he is charged. Unless he has business sense, however, he cannot hope to succeed.

Many young men with a knowledge of the uses to which materials, machines and devices are put in construction, and who possess a liking for business, enter sales work with supply houses. Excellent opportunities for advancement, with attractive salaries meanwhile, are often available for the right men, with supply firms handling cement, steel, tile, brick, stone, timber or contractors' equipment. A young man who makes good in work of this kind will generally find it easy to pass into important and remunerative executive or managerial work, often in fields only remotely connected with engineering.

## FIRE PREVENTION

By A. L. Irwin, 2T1

FROM the beginning of time fire has played an important part in the evolution of the world. Without the heat from the sun there would be no life here; absolutely everything depends on it, and it is the basis of all the progress and change in the universe. But we are not dealing with solar rays and the highly interesting phenomena of heat and light now—we have in mind mere fire, the combustion of inflammable materials by ignition and the destruction or damage to many materials by exposure to heat developed by fire.

Fire has made and unmade continents; it has been turned into steam, light and electricity, and with it nine-tenths of our food is prepared. Properly under control it is man's greatest servant, whilst unharnessed and running amuck it can destroy in an hour what nature has taken centuries to make and what man has spent a lifetime in fabricating.

Ever since man left his early life in the caves of the earth and has lived in communities; in the fashioning of his many kinds of habitations, he has, in his choice of inflammable building materials laid, as it were, the foundation for the conflagrations and terrible fire waste of the present day. His early huts were of skins and as time went on he built with wood and other combustible substances, a practice which has been continued to even the present day. Thus we have a situation in which these materials of construction, combined with ignorance or carelessness on the part of man furnish all the requirements for a wasteful and desolating fire menace.

With this state of affairs persisting we have surely a great need of increased care and better education for the people in the matter of fire prevention. One authority states that in the matter of fires carefully tabulated for twenty years , proven carelessness alone has caused more fires than electric wires, lightning, cyclones or explosives all put together, in the same space of time. Thus it goes on, year after year, destroying life and property until the point has been reached when every man, woman and child in the Dominion must be made to realize that this national phantom of death and destruction must be subdued and that not merely fire *protection* supplied, but the broader science of fire *prevention* practised.

Wasteful conflagrations occur everywhere, out in the wilds as well as in civilized parts. Millions of dollars worth of timber lands are destroyed every few years by forest fires, although it is certainly very gratifying to know that the system of "fire ranging" and the patrolling of the forest lands during seasons when fires are likely to occur is surely controlling the loss by fire from this source. The prevention of fires in more thickly populated centres covers a very wide field and is closely allied to every phase of the life of the people. In order to describe the various means of fire prevention which can be practised in all the different branches of industry as well as those suggested for the homes, one would need volumes, so the writer intends to confine himself to the subject of fire prevention in the industries with which he is most closely connected, namely the metallurgical and other industries allied with the production and manufacture of metals and metallic materials.

In no industry is fire used so extensively as in the metallurgical industries, and on account of this no settlement or community of people is so much in danger from fire and conflagration, as those in which metallurgical industries are centred. On account of the need of metals of various sorts in the construction and equipment of factories and dwellings these metal plants must needs be situated in centres of civilization, hence the risk is indeed greater than if they could be placed out in the more sparsely settled sections.

What then are the precautions that should be taken to insure the safety of these people's lives and homes? Care, diligence and the same practice of fire preventive measures must be practised by both the people and the industries.

Let us first consider the construction of such plants. An engineer about to build a plant of the nature under discussion must necessarily choose from several types of construction, and in his selection the governing considerations should be cost, safety, durability and fire protection, while many minor factors also enter the case. Four general types of buildings are available, viz.

1. Frame construction.
2. Mill or slow burning construction.
3. Steel construction.
4. Reinforced concrete construction.

Although the frame construction is cheap, its lack of service and its extreme fire risk exclude it from use about metallurgical plants. In plants which have the idea of absolute fire-proofedness embodied in them, even the slow burning construction of huge, heavy wooden beams and joists is done away with, because of the necessity of having nothing but non-combustible material used in their make-up.

Steel construction and reinforced concrete are, however, used largely in the construction of buildings, housing blast furnaces and roasting and refining furnaces. In this type of building the skeleton-like steel frame work with corrugated iron roofing and sides is very much the rule, and reinforced concrete is only used for second floors in a few odd cases.

Besides the general make-up of the building are the many little details which go to make up the efficiency of the fire prevention crusade in the plant. Around many smelting and refining plants one sees old wooden shanties used as tool or stock rooms, quite within reach of sparks and easily ignited. These could be replaced to a great advantage with corrugated iron houses. All electrical lines should be carefully enclosed in iron conduits and electric overhead cranes operating in the building should be protected from the heat below by a bottom of asbestos board. The burning out of motors and control boxes caused by this overheating is quite common, and there are cases on record where the oil and grease present as lubrication caught fire and badly burned the operator before he could dismount from the crane.

Departmental offices used by foreman and superintendents should be constructed of brick and have roofs of slate or tile. In many smelters are still seen the old-fashioned wooden bins for storing ore and flux as well as coke. These bins are a source of danger from fire and, peculiarly enough, in most plants, although situated quite near the furnaces to ensure easy charging, they are not accessible to any high pressure water system. They are generally constructed of a skeleton framework of wood and boarded up with two in. boards. The one remedy for this condition is the introduction of steel bins with hopper bottoms and loaded by conveyor belts, thus eliminating the fire risk, and instead of having to build wooden trestles to carry the ore trains over the bins, the cars are discharged onto the belts and the bins filled in an economical method.

The function of the cars carrying material to the furnaces, is in many plants to carry the charge over the top of the furnace, stop, discharge the load, and move off for another load. At times when the furnaces get down quite low, due to a holdup in the charging for some reason, hot flames issue from the furnace tops and, the cars , if electrically operated, are in danger of becoming overheated and the motors burned out. They should be, therefore protected by having an asbestos board placed on the bottom of the electrical motor and equipment.

Refineries, brass works, and ornamental metal industries are extensive fields for the exercise of fire prevention. They are, as a rule, situated in the heart of industrial districts, and on account of the nature of the work done, must be closely guarded against possible fire.

They are quite often built of brick and of steel frame construction. Reinforced concrete is also becoming a great factor in the construction of buildings to house these industries, because of its great fire resisting properties. Concrete floors are generally the rule and any wooden window frames or interior fixtures are covered with a coating of iron oxide paint.

In electrolytic refining rooms precautions must be taken to prevent fire from defective electrical installations. Foremen should be made inspect all connections daily and see that the electrical staff repair any major breaks. One improvement noted in some plants is the replacement of wooden slat or board walks between the refining tanks by a flooring of asphalt and slag roofing over tiles, in order to prevent spontaneous combustion due to the action of nitric acid fumes on the wood, a thing quite common in plants using this in their process.

In addition to the general construction of plants, and works in the metal industries in order to keep fires down to the minimum, Departments of Safety and Welfare are organized, which have the matter of fire prevention as a large portion of their work. Notices, pictures, cartoons and placards are placed conspicuously about the plants, exhorting the employees to greater care in the prevention of fires, and give many examples of how fires are started by carelessness on the part of men working in the different departments. Receptacles of sheet iron are placed generously throughout the plants, and the superintendents and foremen are instructed to see that all paper, rags and waste material of a combustible nature are placed in these cans, and that they are emptied regularly every day. Fire extinguishers and fire hose, as well as buckets to be used in case of fire, are placed at strategic points about the plant, and most plants of to-day have a fire alarm system connected with the engine-room where, when an alarm is rung in, the engineer gives a signal on the whistle indicating the position of the fire and volunteer fire brigades are smartly on the scene of the fire. Fire drills are held from time to time to keep up the standard of the brigade.

It is essential that all oils and explosives be kept in houses by themselves or in tanks underground, and that no smoking or naked flame of any sort be allowed near them. Regarding waste oil in old cleaning rags or engine waste, most plants have in their engine rooms centrifugal waste cleaners in which the oil is separated from the oily waste material by whirling about in perforated drums filled with live steam. The centrifugal force developed throws the oil to the outside of the cylinder and through the perforations into another surrounding container, and in this manner a great saving is effected, and the danger of oily waste lying around is quite eliminated. The foregoing illustrations go to show what can and is being done along lines of fire prevention in plants in the metal industries, and many of them are common to most industries where fire plays a large part in the programme of operations.

We must also think, however, of the homes of the workers and what measures should be adopted for the prevention of conflagrations, which might possibly result in the destruction of life and property. Of all classes of buildings, houses contribute by far the greatest number to fire, because people still insist on having homes of more or less wooden construction, although many are learning the folly of flimsy buildings. Many people, too, believe that as long as they have the outside walls of their houses of brick or stone, and the roof of tile or slate, that they have fireproof homes. Such is not the case, for as soon as a fire gets going in the wooden rafters or floor joists, the outer walls only act as a furnace in which to burn up the interior, endangering lives and ruining valuable household possessions. The best plan is to have the outer walls of brick, terra cotta or concrete and the floors, partitions and roof of absolutely non-inflammable material. The lengthened life of the structure and the saving in fire insurance and fire loss soon overcomes the extra expenditure, to say nothing of the ease of mind secured.

It is a mistaken idea, too, that houses of fireproof material are unattractive and flat-looking. In the hands of a skilled architect they can be made beautiful examples of the best in home decoration and design. Many fine houses suitable for occupation by the working man in the industries are being constructed nowadays of tile, stuccoed externally; an inexpensive construction whic is fireproof and does not call for the more expensive steel construction.

Fire insurance is looked upon by many people as a protection to their homes, but is it? True, it repays in many cases nearly the value of the edifice destroyed, but it does not recover the lost articles which are of more than intrinsic value to the owner, nor yet eliminate the possibility of loss of life. Insurance in some form or other will probably be always necessary, but the sane course to take is to build so that insurance need only be carried on the contents of the home and to carry out simple procedures to prevent the occurrence of fires that are a menace to both building and inhabitants.

To arouse the people against the fire foe is the task of those interested to-day. The average citizen would, if presented with statistics, undoubtedly admit that our fire waste is in the form of a national disgrace, but the great problem is to make him do something to remedy conditions. The remedy is to bring home to him the gospel truth of fire prevention, which is the science of so constructing, protecting and occupying buildings as to minimize the danger of fire, and should not be confused with the narrower definition of fire protection. A fire department appeals to our love of the dramatic, but it is complicated, costly and only too often inefficient. On the other hand, fire prevention with its unbounded scope for efficiency is simple and inexpensive.

No man may directly commit murder or destroy the property of others, no matter how much inclined to do so, and, therefore, equally no man should be permitted to do either of these things indirectly by needlessly, carelessly or selfishly refusing to take the necessary precautions to prevent dangerous fires.

So the movement must be popularized. Organized methods must be adopted for bringing the significance of the fire peril before every person and for the passing of laws compelling the practice of fire prevention. Let the people once realize the exact facts of their own negligence, and they will be swift to provide the cure.

## MODERN ENGINEERING PROJECTS *

By T. Kennard Thomson, S.P.S. '86.

MR. PRESIDENT and Gentlemen of the Engineering Society. I certainly appreciate the honor and opportunity of addressing you to-day, and I never miss an opportunity of coming back to the Old School when it is possible for me to come.

This continent is now in one of the most critical stages in its commercial history, and I trust that you gentlemen of Toronto will do your utmost to prevent any monumental errors similar to those in the past, when the development of the St. Lawrence and Niagara Rivers is considered. A treaty with the United States of America will be necessary, and the entire matter should be taken up as one international unit.

It sounds like a paradox to say that a successful business man is naturally narrow-minded, but, on the other hand, there really seems to be some ground for such a statement, as most men succeed by concentrating their energies in one or two directions, and after they have reached the top rung of the ladder, they, forgetting that their experience has been limited to comparatively few lines, give their opinion freely on many subjects of which they know nothing. Or on the other, as the President of a great Chamber of Commerce once told me, his Chamber of Commerce would never endorse any project until that

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*Address delivered before a meeting of the Society on November 12th, 1920.

project was an assured success. This being on the principle that the members who had reached the top rung of the ladder through business sagacity and good judgment, were not going to jeopardize their reputation so gained, by endorsing something which might not be eventually carried out.

It seems a great pity that very recently this point of view has been taken in many parts of the country, Boston, New York, Buffalo, Montreal, etc., by some individuals in each of these places, against the deepening of the St. Lawrence River and the development of the water power in the Niagara and St. Lawrence Rivers carried out on a rational basis would result in from six to eight million horsepower a year being developed, and the saving of from sixty to eighty millions tons of coal a year. This would result also in a dozen manufacturing centres, each greater than old Pittsburg, on or near these two rivers.

The chief cities to be benefited by such an undertaking would be the very ones just mentioned as so strenuously objecting to this great undertaking, although, as a matter of fact, every part of North America and many other parts of the world would be benefited.

Even apart from the great industrial centres thus created, the saving of cost of handling wheat and other products of the farms of the Canadian Northwest and the great Western and Central States alone would benefit the entire continent.

It seems hard for many to realize that the country is like a human body, and anything that injures one part of it, injures the whole; the most insignificant splinter in the finger being sufficient to upset the whole system. It is hoped that you will pardon the allusion to such common and well known conditions, but there is really great danger of such an elementary mistake being made at this most critical stage in our economic history.

Some years ago the former President of the New York Central Railroad made a remark that some people thought that his road was antagonistic to the Panama Canal, and he very truthfully stated the fact that the Panama Canal could .not but help build up the Pacific Coast, and that anything which built up the Pacific Coast must naturally benefit all the great Transcontinental Railroads.

For the same reason the creation of the great manufacturing centres at our northern boundary would keep all the railroads, canals and other industries of the country busy.

One of the great blunders in history was the New York Barge Canal which replaced the old Erie Canal.

The old Erie Canal was built originally with a four-foot depth from 1817 to 1825, and was really a wonderful undertaking, considering the appliances and the wild country it was carried through. It cost about $7,000,000 and collected its entire cost through tolls by 1832, although it reduced the cost of freight from $100 to $30 a ton.

It was enlarged and deepened several times, and tolls up to the time they were abolished in 1882, brought into the State something like $135,000,000 or about $9,000,000 more than the entire amount expended on the Erie Canal up to that date.

The economic blunder referred to consisted in turning the Erie Canal into the so-called Barge Canal, which means that no boat standing more than fifteen and one-half feet above water could pass under the fixed bridges of the new Barge Canal.

This expensive blunder was made in order to placate the people of Buffalo, and to obtain their vote for the project; while, as a matter of fact, the people of Buffalo voted against the entire project anyway.

This very short-sighted action of Buffalo was on the assumption that if the lake boats could pass through the enlarged Erie Canal, Buffalo would be handicapped by the loss of the employment of stevedores now due to the unloading and reloading of ships in Buffalo. They might have known that work resulting from enormously increased traffic which passed through the canal would have given Buffalo a great boost, and it would be just about as stupid for people to say that if the New York Central Railroad discharged all of its ticket choppers and porters that the business of New York City would be ruined.

It is also on a par with the opposition against the First Railroad in America, when horse owners combined to fight the railroad project, thinking that there would be no use for their horses after the construction of such railroads.

None were more surprised than these same horse owners when they found that far more horses were required than ever before to handle the merchandise to and from the railroads.

The deepening of the St. Lawrence and development of water power in these two rivers would result in a solid city on both sides of the boundary line from Lake Erie and Lake Ontario, thus enormously enlarging the area of Buffalo, which has remained stationary for almost a hundred years. The first part of the St. Lawrence River work just above Montreal would, as Sir William Van Horne stated just before he died, make Montreal one of the really great ports of the world, and it seems certain that Toronto and Western Canada, as well as New York, would also be the gainers, to an undreamed-of extent, by the construction of so many new Pittsburghs, and the great saving in cost of bringing all the products of the farms to the market and increasing the number of such markets.

The New York Chamber of Commerce, in opposing this undertaking, did so on the ground that New York City paid 25 per cent. of the entire tax of the country; that she had a great harbor, had expended millions on the Barge Canal; and on account of the great cost to the two Governments of canalizing the St. Lawrence River, which it was stated by their experts, would be from three to five million dollars.

The fallacy in these arguments seems to be:

First, if there were no farms, factories, villages, towns, or cities, etc., outside of New York City, there would be no New York City, and on the other hand, every dollar's worth of prosperity of any farms, factories, villages, towns, or cities in the New York State; in the United States; or even in Canada, results in a share of the profits reaching New York City, on the basis as stated by the Chamber of Commerce of 25 per cent. of the entire wealth of the U. S. A. On the other hand, the prosperity of New York City benefits every part of the continent.

On this assumption New York owns mines, farms, ranches, and all of the products thereof, although many of these products never come within hundreds or thousands of miles of New York City. Surely if all these articles, instead of being shipped to the consumers by the shortest and most economical routes, were to be shipped to New York City, unloaded, reloaded, and then shipped to their final destination, New York City would not only lose much of her present profits, but the cost of articles to the public in our country and many other parts of the world would be greatly increased.

Yet Buffalo thinks that such unloading and reloading would benefit Buffalo.

Many years ago, the President of a Bridge Company told me that if he lifted a steel plate six inches, it cost him money, and if he then changed his mind, and put it back in its original position without having accomplished any good purpose, he had wasted money. That means, of course, that all unnecessary handling should be eliminated. Elementary certainly, but often ignored.

Once more pardon me for saying that it is hoped that you gentlemen of Toronto will make these simple truths so obvious to the great public that they will be seen and believed

Always be constructors, not obstructors, as it seems impossible for anyone to excel in both lines. There is very little use in criticizing or pulling to pieces another men's plan unless you can submit something better.

At the present time ocean-going vessels can reach Montreal without the aid of any locks, the elevation of the water in the harbor of Montreal being about 24 feet above the standard mean level of the ocean.

It might be stated here as a matter of fact, that the rise and fall of the tide of the City of Quebec is about 20 feet or more.

Just above Montreal and below the Lachine Rapids, the river widens out into a big bay, in which ice often accumulates and occasionally causes more or less serious floods in the City of Montreal. The first step of my project is to build a dam in the Lachine Rapids across Isle Heron, so as to raise the water to the high-water level of Lake St. Louis, which is 74 feet above the ocean level, then dredge the channel to the width of the St. Lawrence River at Montreal up to this dam. In reclaiming the rest of the land now covered by this bay, we could add 10 square miles for great manufacturing sites to the City of Montreal, which will be amply connected with every part of the city by adequate tunnels. Locks at the side of the dam would raise vessels 50 feet to Lake St. Louis. We could develop at this site one million horsepower. This is the project which the late Sir William Van Horne said would make Montreal one of the great ports of the world.

There are now a few water power companies at Cedar Rapids, Messina, etc.

Only three or four lifts between Lake St. Louis and Lake Ontario would be required, and these would give 3,000,000 horsepower more.

Then there is only a rise of two feet in the whole length of Lake Ontario, which is about 240 feet above sea-level. From Lake Ontario to Queenston, some seven miles, the Niagara River rises another two feet.

From Queenston to the base of the old Falls, there is a rise of 102 feet in the Niagara River, which we want to take advantage of by building a dam in the Lower Rapids in the Niagara River, which has a minimum flow of 220,000 cubic feet per second. This means that our dam would handle the entire minimum flow of the Lower River, giving us the maximum amount of power at the minimum of cost, or 2,000,000 horsepower.

By referring to the map, you will see that we can build the first half of this dam on Foster's Flats. That means that this part of the dam would be built on what is now dry land.

The base of the dam will extend some 35 feet below the present bed of the river, so it will then be possible by means of large openings in the bottom of the dam to divert the river through the dam away from its present channel.

It will be then a comparatively simple matter to finish the dam across the present channel of the river.

In so utilizing the 102 feet drop in the river we would not affect the old Falls nor the present power plants in any way whatever, but as the 2,000,000 horsepower we would develop would soon be inadequate to supply the needs of the people, we have a plan for any further diversion of water which may be permitted by the International treaty. This plan consists of extending Goat Island 1,000 feet or more up the river, and building inclined tunnels to take advantage of the 200-feet head. These tunnels would be about 3,500 feet long and would give us the most economical method of developing water power resources of the upper Niagara River.

The reason for extending Goat Island is because the drop in the old Falls is 165 feet, and there is a further drop of about 50 feet within a mile above the Horse Shoe Falls.

When my project for a Niagara Falls Junior was first published, many laughed at the idea of ever using 2,000,000 horsepower in this location, so letters were written to many; with one very satisfactory reply, which was a very complete letter from the Hon. Samuel W. Rogers, who, in answer to my questions, summed up the sources of power then being utilized in New York State, which he gave as over 3,000,000 horsepower a year. He further stated that the normal rate of increase was ten per cent. or 300,000 a year. In other words, if half of our power were used in New York, and the other half in Canada, New York would only obtain one-third the amount of power she was then using, or enough to supply the normal increase in demand for three years.

The diagram shown on the screen, having Niagara Falls as the centre, and circles with the radius of 100, 200, 300, 400, and 500 miles from the Falls, was then published by me. This diagram shows by means of black streaks the present distribution of power from Niagara Falls.

This power is now transmitted, using 60,000 volts, to Syracuse, a distance of 160 miles, with the loss of less than ten per cent.; it is also distributed to the Detroit River with a similar loss by raising the voltage to 110,000, a distance of 250 miles.

By increasing this voltage again to 220,000, the distance of transmission could again be doubled. Therefore, it would be perfectly feasible to distribute Niagara Falls power within a radius of 500 miles.

Inside of this area, we find Quebec; Augusta, Maine; Richmond and Raleigh, in Virginia; all of Lake Michigan; and part of Lake Superior.

In other words, the 500-mile radius from Niagara Falls would include nineteen States of the Union and two Provinces of Canada, and inside of this area is 60 per cent. of the entire population of the United States and 80 per cent. of the entire population of Canada, all of which would then be within commercial reach of Niagara Falls power.

It would seem, therefore, very much better to use this power within 100 miles of the Falls, thereby following the example of the five pioneer companies, who staked their courage, money and experience in what was then an untried venture, and developed some 650,000 horsepower at the cost of $65,000,000, or $100 per horsepower.

In doing this they attracted private capital to the extent of $650,000,000, or ten times what they spent themselves, thereby creating many new industries and enormously reducing the cost of many articles such as aluminum, carborundum, etc., which reduction in cost benefits nearly everybody on the continent.

If we developed 4,000,000 horsepower in the Niagara River and sell it at the site, we would create the greatest manufacturing district the world has yet seen. Whereas, if we tried to distribute it broadcast, the result would be, considering the Province of Ontario and the State of New York, as if a glass of water were thrown over this audience. That is, the proportion of people who would be slightly benefited by this power in the Province of Ontario and the State of New York would be in the same proportion as the number of you gentlement who would receive a few drops of this water.

It is very hard for people to realize the certain results of public ownership. We have tried public ownership of railroads, telephones, and many other things in this country, and Canada has also had much experience with similar results.

After public ownership of harbors in New Orleans, the city is begging private individuals to take hold again.

The same action has been taken by other municipalities in connection with gas works, etc.

This Province has made a great effort with public ownership of water power, and it was able to buy up much more power from the old companies at from $9 to $15 a horsepower, which would be absolutely impossible now, not only because the companies have learned the value of such power, but also because the cost of developing power by coal has increased so enormously.

Ontario Hydro then built transmission lines, distributing this power, selling much of it to consumers for one and one-half cent to three cents per kilowatt-hour.

It should be remembered that one and one-half cents kilowatt-hour is $100 a horsepower, and three cents kilowatt-hour is $200 a horsepower. So that the Government Commission which bought power at nine to fifteen dollars and borrowed millions of dollars for transmission lines was then able to sell power from $100 to $200.

Not having enough power to go around, the Hydro Commission then decided to build a canal of their own, the Chippawa-Queenston Canal, some twelve and three-quarter miles long. This was originally designed for 10,000 cubic feet per second, with a grade or loss of a head of eight feet.

The plans were subsequently changed to give a capacity of 16,000 cubic feet per second by increasing the depth so that the grade or loss of head would be 16 feet.

You gentlemen, of course, know that the so-called horsepower is the work done equivalent to lifting 33,000 pounds one foot per minute, or 550 pounds one foot per second.

You also know that on the basis of 80 per cent. efficiency a cubic foot of water weighing sixty-two and one-half pounds and dropping 11 feet, will give 550 foot pounds per second, or one horsepower.

So we generally consider that one cubic foot of water dropping eleven feet per second is equivalent to one horsepower.

But when we sell a horsepower for $15 or $30, we mean 550 foot pounds per second for the entire year.

As the Chippawa-Queenston Canal will carry 16,000 cubic feet per second with a drop of 300 feet, the result would be less than 450,000 horsepower. But two-thirds of this power, or 300,000 horsepower could be obtained at a trifling expense, comparatively, by our short Goat Island Tunnels, so that the twelve and three-quarter mile canal will only give 150,000 horsepower per year more than could be obtained directly without this long canal.

The original estimates were something like $10,000,000. It is now conceded that the cost will be $55,000,000, and some claim that it will be much more. In fact, the probabilities are that, while the Chippawa-Queenston Canal will carry 16,000 feet per second, our dam would take care of the whole 220,000 cubic feet per second, and probably not cost much more at that.

Our Niagara Falls Junior, complete with power plants, etc., should not cost $100,000,000.

So if you will pardon the egotism, it seems obvious, that these projects will give the maximum amount of power at the minimum of cost.

On June 1, 1918, *The Scientific American* published an article by a former Engineer of Ontario Hydro in which he advocated the diversion of the whole flow of the Niagara River through the proposed Chippawa-Queenston canal by means of a series of canals, four being shown on the plan, of which one is now nearing completion. It was advocated in this article that a dam built above the Falls would, of course, necessitate preventing of any ice leaving Lake Erie. They, therefore, advocated an ice boom in Buffalo.

It would certainly take "some" dam to hold back all of the ice in Lake Erie. for there is a break-water at Buffalo now standing some 15 to 20 feet above the water in summer which the ice and waves pass to a height of 15 to 20 feet above the top. As Lake Erie is subject to violent storms, it would seem impossible to hold back the ice without disastrous results, flooding much country, etc. But even if it were possible to so hold it back, it would absolutely interfere with the navigation for several months every spring, resulting in cold and late springs every year.

It seems to us that our Niagara Falls Junior affords the only method of controlling the ice in the Lower River, for we would have a minimum depth of water back of our dam of 135 feet, a minimum flow of 220,000 cubic feet per second and a restricted channel. As our dam will have very flat slopes both up and down stream, there would be nothing to stop the ice on the up-stream side, and the ice would have no drop after passing over the crest, as it would simply slide off into the deep water.

On the other hand, it seems that any and every other project proposed would surely result in a catastrophe, for there is barely enough water now passing over the rocks in the Rapids to carry the ice away, and even if ten per cent. or twenty per cent. of the water were diverted from the Rapids, it would seem to make the danger of an ice jam almost certain.

An engineer should not make such a drastic statement as this without some proof. So we might cite a case of some dozen years ago, when a change in the wind at Buffalo held the water back for a few minutes, resulting in an ice jam in the Lower Rapids, which lasted eight hours. Before the jam broke it had backed the water up at least 60 feet in height until it did considerable damage to the old power plants, and when the jam broke it carried out absolutely everything in the River below, wharfs, buildings, trees, shrubs, etc. The only reason that the damage did not cause a greater financial loss was because there was nothing left to destroy.

As an engineer should not stop at one example, we might go back say 12,000,000 years,—perhaps a few seconds more or less,—when something caused a jam in the Niagara River, and made it turn a right-angle, thereby forming the Whirlpool, cutting the brand new channel out of bed-rock. And it seems more than probable that nothing but an ice jam could divert this 220,000 cubic feet per second, and make it cut a new channel out of bed-rock. Surely this dam could not have been built by beavers, although a friend of mine has told me that there is a dam in Massachusetts which he claimed was built entirely by beavers from one end to another. My friend doubted this statement, but was positively assured that it was so.

He then said all right, he always knew the beaver was a very smart animal, but it was the first time on record he ever heard of a beaver that had foresight enough to put a six-inch cast iron drain-pipe in its dam.

While it seems to us that it would be probably unsafe to divert even ten per cent. of water from the Lower Rapids, other engineers have recommended 40 per cent. to 50 per cent. diversions, which seems very extraordinary reasoning, as it sounds like a statement that while the whole flow is not sufficient, half the flow might be. But in this connection they claim that they will have controlling devices in Buffalo which would wipe out any jam that might occur, by holding back the water, so that the flow could suddenly be increased from 200 to 300 thousand cubic feet per second.

In the first place, it would seem very hard to hold back the water without holding back more ice, and it would be more apt to hold back the ice and let the water pass through, making a worse condition than ever. But if the flow were suddenly increased 50 per cent. in the Niagara River, it would make it exceedingly dangerous, to say the least, for anything that might be in the river.

There is another argument that has hard work penetrating my skull, possibly owing to my Scotch ancestry. It is that the poor old Horse Shoe Falls are being destroyed by the great rush of water, and that the way to protect these beautiful Falls from further destruction is to prevent so much water passing over them.

It has always seemed to me that ice and logs do more damage than water, and that if the same amount of ice and logs were carried over by half the amount of water that the damage might be much greater. The question was asked me, what right or reason there was for the statement that the ice would do more damage than the water. But surely any of us would prefer to put our heads under a flow of water than of ice cakes, as we are not like the colored gentleman in New York who recently allowed a mule to kick him on the head, thereby breaking the leg of the mule.

A minister who prepared me for confirmation some forty years ago, told me a story to illustrate his point, which is well worth remembering. The point was that if you cannot do a thing in the right way, you had better not do it at all. The case cited happened off Yonge Street wharf in Toronto the preceding week, when a man saw another man struggling in the water. After yelling, "Help! help! Why does not somebody save him!" and finding nobody to do so, he decided that he would have to make the effort himself. So he seized a large log and threw it to the poor chap in the water, hitting him squarely on the head and thereby knocking his brains out. As the minister properly remarked, it would have been better if he had not tried to help.

Now while we have got all the possibilities of building up the greatest industrial centres in the world, surely no mistake should be made at this time.

If this stupendous work were undertaken by Government ownership in the old sense of the word, God help the countries! On the other hand it is absolutely inconceivable that the two Governments would give concessions to any combination of individuals, giving them private ownership, in the old sense of the word, of rights which might be equivalent to 80,000,000 tons of coal a year, or $800,000,000 a year, and to let this work to individuals on a percentage basis, would be the same as Government ownership. So our proposition is that the two Governments get together and give us the rights to canalize the St. Lawrence River and develop the water power in both the rivers under strict Government supervision as to plans, construction, operation, selling-price of power, amount of taxes to be paid, and our remuneration, on the basis that if it costs us say $15 per horsepower, our remuneration would be so much; if more than $15, our remuneration would be less; but for every dollar we save below $15, we would get the lion's share. That means that we would have every incentive of a private ownership to go ahead and do our—————that is to say, build the most economical dam.

While on the question of price, it might be stated that it does not make any difference what price power is sold for, it will always be worth just exactly what it cost to develop it by coal.

Now the cheapest power developed by coal in New York city before the war, was by the New York Edison and New York Interborough, and it cost them on the average of $32.19 a horsepower to develop such electricity by coal. That means that $70 or $80 a horsepower now in the States and far more in Canada.

As a matter of fact, it was testified before the Federal Power Commission in Washington on January 25th, that individuals who have to use coal are now paying $100 a horsepower at Niagara Falls. And the Canadian Manufacturers' Association told me it is now costing over $90 a horsepower in the City of Toronto. If therefore pet consumers get power from $9, $15, $20, $25, $30 a horsepower, they will have a very unfair advantage over their competitors who have to pay $90 or $100. Now our proposition is that part of this difference be made up by heavy taxes. The Ontario Hydro Commission is now protesting against a tax of $2 per kilowatt-hour, which is less than one thirty-second of a cent per kilowatt-hour. But if the Government were to tax us $30 a horsepower it would be less than one-half of a cent per kilowatt-hour, and if it cost us $15 to develop the power, the consumer would only have to pay $45 a horsepower, and even then the users of our power would get it for half of what it costs their competitors, who would have to use coal. And if this tax were paid on 6,000,000 horsepower a year, it would mean that a tax of $180,000,000 could be divided between these two countries.

The cost of canalizing the St. Lawrence and developing the water power of both rivers would be about one billion dollars. A tax of $30 per horsepower would be 18 per cent. of the total cost. In addition the countries would have the benefit of cheap power and the saving of 80,000,000 tons of coal a year, and vast industries constructed to the great benefit of practically everybody in the United States and Canada, as well as almost every part of the world.

# METHODS THAT MAKE FOR SUCCESS IN THE APPLICATION OF COLLEGE THEORY TO WORKS PRACTICE *

By Harold J. Roast, F.C.S.

AFTER accepting the invitation of your Secretary to come to Toronto to address you, I was somewhat at a loss to know what subject to choose.

During the last eighteen years I have frequently met with the College graduate as he was leaving his Alma Mater and coming into contact for the first time with commercial life. As a result I have been much impressed by the difficulty the graduate often experiences in endeavoring to make that progress that might reasonably be expected from the knowledge gained during university work.

While we realize that the college curriculum can only lay a broad basis upon which to build, rather than to erect the finished edifice, nevertheless it is to be expected that the erection of a permanent structure in the commercial world should be decidedly hastened by the systematic training undergone.

It frequently happens, however, that much disappointment is experienced at the slowness of the progress made, or even, in some cases, at the retrograde action which develops. The fact that later on the worker finally adjusts himself to his environment does not compensate for the time lost in the interval. These facts having come to my attention repeatedly, prompted me to make the subject of my address to you as advertised, namely, "Methods that make for success in the application of college theory to works practice."

Every student as he enters the University wishes for success in his examinations and for the final success of his degree. On leaving 'Varsity and entering upon his life work, he realizes that still more momentous possibilities await achievement, and feels instinctively, to some extent at least, the greatness of those forces with which he will have to cope.

Are the requisites for success in the University life the same as those which bring reward in the commercial world?

The answer is in part affirmative. Earnestness, interest, application, and perseverance, are common to both. One may acquire knowledge in the course of college training, however, by pursuing an isolated course, being even boorish to one's confreres, and unpunctual in one's appointments. The business world, on the other hand, demands of its really successful pupils, that they cultivate the society of others, that they develop a courteous personality, and be punctual in all their engagements. Tact and diplomacy without which one can makeshift to get through college are vital factors in successfully solving the commercial equation.

*Given before the Chemical Club on January 28th, 1921.

In these days when the scientific man is being recognized as never before, it is vitally necessary that he take care not to limit his sphere of usefulness by want of attention to basic principles which stand out clearly as fundamentals in the commercial world.

The chemical graduate has generally two avenues open to him through which he can commence his career. Either that of instituting chemical control or joining the chemical staff of some company as a more or less routine assistant for the time being.

Let me deal in the first place with that type of graduate, who is fitted to fill a responsible position, and has under consideration the entrance into the activities of a large company. Let us suppose further that he is a chemist seeking an opportunity to develop the chemical side of such an institution that has operated for many years without chemical assistance. The most important point in such a case is to get the right relationship established between himself and the company.

**Right Relationship**

If the company consists, as most companies do, of many departments, each with its own manager, it is very advisable that the chemist be responsible to some one who is a neutral party as to these departments, such for instance as the General Manager, Managing Director, or Board of Directors.

Such a relationship will enable him to serve any or all departments freely and to avoid much of that trouble that arises out of inter-departmental jealousy. Again it leaves the man free to draw attention to possible waste in *all* departments, instead of feeling that if he remark on this or that weakness in that particular department to whom he is responsible, he runs the risk of antagonizing his immediate chief, with the possibility of losing his position.

Too much stress can hardly be laid upon the importance of "Right Relationship." It is so much easier to arrange such a matter before entering a concern, rather than to endeavor to have a change made after one has become part of the system. In the latter case it is often impossible to suggest the change without it being thought that personal differences are at the bottom of the request. In the former case one acts with presumably no knowledge of the personnel of the staff or the personalities involved, being actuated only by a desire to serve the company in the most efficient manner.

**Attitude of Mind**

Having established the right relationship, probably the next most important thing is the attitude of mind of the worker. Ofttimes a wrong impression is created by the graduate, because he takes a didactic rather than a receptive attitude towards those who are actively engaged in carrying on the operations of the company. This means that an impression is created that the chemist has come to teach the men and managers how to run their business, which business has probably been conducted along more or less successful lines for many years. Naturally this attitude is resented, and an atmosphere which is not conducive to co-operation is created.

If, on the other hand, the chemist approaches his work in the company in a receptive state of mind, being willing rather to learn from those already in the business, that which they may have to teach him, rather than to undertake to teach them his viewpoints before he has a solid basis for them, a spirit of tolerance is created which later on may develop into friendly co-operation.

**Tact**

What has been said of the attitude of mind is closely associated with the next most important requisite for the successful development of chemical or any other work, namely *tact*. This small word "tact" is one of the most important in our language, for the lack of it many a forceful and able worker has made no progress, and in place of building up an organization by the strength of his personality has, by that very strength itself disintegrated the organization that already existed. Tact might be described as the realization of the other man's viewpoint, and a readiness to so represent your suggestions as to have the other man feel that they really are his own. Tact also involves an appreciation of that old world courtesy which is given alike to master and man.

Remember that it is very essential that you study men as well as material; you will have to work with both.

It may be well at this stage to leave generalities and to take up the active life of our chemical graduate as he starts in in real earnest to apply his technical knowledge to the works practice.

**Study of Operations**

Bearing in mind the receptive attitude already referred to, a careful study of the operations of the plant is the natural preliminary to devising a routine technical control. In such a study it is well to go slowly and acquaint oneself with the difficulties and arduousness of the various operations involved. The making of such a study should include the getting down to the plant as early as the first workman and remaining until the last man leaves, or, if the operation is continuous, then remaining one entire twenty-four hours, as well as repeated visits on other days during reasonable hours. Opportunity should be made to try out any specially tedious work in order that a more accurate appreciation may be had of the effect of the labor involved upon the workman. If the foregoing plan be adopted then the securing of really accurate data should be readily accomplished. Many an improvement suggested has proved futile, owing to the insufficiency or inaccuracy of the data upon which it was based.

**Improvement Decided Upon —Bibliography**

Let us now assume that the chemist has noticed a stage in the manufacture that he thinks is capable of improvement, and that he has an idea as to the nature of this improvement. Before devoting much time to the working out of the detail one is well advised to make as thorough an investigation of the bibliography of the subject as can be. In many cases it will be found that the ideas which have been conceived in a broad way have been already worked out in minute detail by other authorities. A study of the literature will frequently enable the graduate to avoid many pitfalls, nor must it be thought to detract from the credit due him.

In the commercial world it is that which has been accomplished in the way of reduction in cost or increase in capacity that is rewarded without regard to its originality. One who digs out past accomplishments and applies them to to-day's problems is at least *as* useful as one who insists in advancing only original ideas.

**Presentation of Idea**

Having worked out the new improvement in theory, it is very desirable that it be tried out in practice in the works in as quiet and unassuming a way as possible. For example, it is preferable to work through a works foreman rather than through a department manager. If the experiment is a success time enough to notify those in authority of the improvement, while if it gives evidence of weakness the less said about it the better. In the satisfactory event of the idea proving itself both practical and economical, the next thing is to present it to the chief or chiefs in the most favorable form. At this stage it is well to remember the saying of the wise man of old time, "Oh, that mine enemy would write a book." Too much haste in rushing in written reports and too great a degree of definition and detail therein will often leave one open to criticism and flank attacks that might never develop if the old saying of "least said soonest mended" were heeded. If a verbal report will meet the case keep the written data for some later occasion, such as the annual report, which will then be able to go with safety into greater detail because of the longer experience to which the improvement has been submitted. Frequently, however, a written report is called for, in which case due regard should be had to the motto, "Brevity is the soul of wit," using the last word in its true sense of wisdom rather than humor.

State only certainties to the management as such, being careful to show the probabilities as possibilities, and leaving out the possibilities altogether.

Clear and concise arrangement of data is, of course, a requisite, and a free use of tabulatory statements is to be recommended, as also a liberal use of marginal subsections such as "Present Operation," "Proposed Changes," "Increase of Production," "Saving Effected," "Recommendations," etc.

**Spirit of Report**

The whole spirit of the report should be that of showing benefit to the department involved, with a minimum reference to the part played by the chemist himself. In any *final* report the effect of any improvement should be reduced to dollars and cents. This is the main appeal to any management, and fortunate is that executive who can clearly show a balance on the right side, even after the financial statistician has checked over the figures.

**Handling of Labor**

As our graduate develops with the company he will possibly be called upon to take some active part in the direction of the labor which is concerned with the improvements he has introduced. In the general issuing of instructions to the men for whose operations you are responsible, endeavor, of course, to give only the most efficient order in each case. If, however, an order has been given, do not change it because a somewhat better way has occurred to you immediately afterwards. To acquire a reputation for not knowing one's own mind is a sad handicap in handling men. I do not want to be misunderstood in this connection, nor to convey the impression that one should be obstinate in allowing a considerable loss of efficiency to follow an unsuitable order rather than to correct it. Nevertheless, I have known many scientific men who, as a direct result of their training in the search after truth, are almost always modifying their orders because of a sudden possible improvement that occurs to them, with the result that the impression is created, particularly in the mind of the ordinary laborer, that "the boss doesn't know what he is talking about."

**Routine Chemist**

So far we have taken up the case of the chemical graduate who enters a company as its first chemist. Many, however, start their professional career by becoming one of a number of routine laboratory chemists. Here, again, the same principles of receptiveness and tactfulness apply. To do accurately and rapidly the work entrusted to him is the first consideration, but no opportunity should be missed that offers a chance of becoming acquainted with the manufacturing end of the company's activities. Such opportunity frequently comes in connection with the taking of samples throughout the works. I have known of more than one case, however, where the routine chemist did not care to leave the accustomed atmosphere of the laboratory to go into, it may be, the rougher and, ofttimes, the dirtier, surroundings in the works. Such a man misses the works inspiration, or power of suggestion that will make itself felt to any trained observer.

Go to the factory for your suggestions and return to laboratory or office to develop them.

The routine chemist who finds or makes the opportunity of getting an insight into works procedure will not always remain a routine analyist, but will assuredly be called upon for work in a wider field.

Do not think that I wish to belittle Routine Analytical Chemistry. This is the watchdog that safeguards the investment of capital spent in raw material, and of reputation concerning the finished product. The chemical industries and, in a measure, all industries, owe much to that type of man who consistently and painstakingly, day after day, checks up the numerous stages of manufacture, who draws attention to dangers ahead, and, often, especially in the case of raw materials, prevents them altogether. Nevertheless, Analytical Chemistry provides after all but the bricks and mortar for use in the working out of problems by dint of careful logical reasoning based thereon.

At the risk of being guilty of going into too much detail I should like to give my ideas in regard to some of the things needing the attention of the works chemist.

**Standards**

One of the first of these is the preparation of "laboratory standards." That is to say, a collection of those raw materials and finished products with which the particular works is concerned, and the composition of which needs to be accurately known. To obtain such standards it is necessary to have them analyzed by other chemists, and that these referees agree closely. It is found that the best people to call in on such work are other works chemists engaged in similar lines to one's own. The man who has his laboratory fitted up for a limited and special line of work, and whose daily business it is to make any given analysis, is likely to have acquired a far greater degree of accuracy than is the general consulting chemist, whose efforts are perforce spread over a great variety of problems, resulting in a less concentrated and detailed knowledge of any particular one. Having obtained such a series of standards as a result of the reports of works chemists, our chemist will be well advised to send samples of these out to such well-known consulting chemists as it might reasonably be expected would be called in by the company in case of disagreement between them and their customers. Very surprising results may develop, but if the matter be persisted in, the chemist will in the end have reliable information as to whom he can appeal to as arbitrator in time of need, either his own or his company's.

Another detail which I have found worthy of consideration is the use, rather than the abuse of, the laboratory note-book.

**Use of Laboratory Note-book**

The purpose of such a book is obviously to record the notes needed during laboratory work, but so often one finds the young chemist entering only the *final* figures of his experiments or analyses. This results in many an error escaping discovery, such as the recording of the wrong number of cubic centimetres used in titrations or the wrong factor applied to a gravimetric estimation. For example, the analysis having been reported, it may be queried, whereupon such questions as: "How many cubic centimetres were used?" "What was the actual weight of precipitate obtained?" "What figures were used in the factor calculation?" "What weight of substance was actually taken for analysis?" etc., etc., naturally occur. If the working notes have been jotted down on pads they are by that time lost, and with them has gone all hope of checking up the work. If, on the other hand, the laboratory note-book has been the recipient of every figure and sketch whatsoever then it will often be to furnish the clue to errors that would otherwise be undiscoverable. Such a system should be followed, even at the expense of an untidy note-book.

**Methods of Analysis**

In regard to methods of analysis for routine control, bear in mind that those operations that permit of the completing of the analysis in the original container have much to recommend them· The simpler the methods the better, as also are those which permit of a wide latitude in regard to the amount present of that element or compound whose percentage is to be determined.

Let us now turn our attention to matters that affect both the chemical adviser and the laboratory chemist. Here we may well bear in mind that every chemical assistant should be so preparing himself, that he may eventually become a Chemical Director.

**Methods of Attack of Works Problems**

Works chemists and works problems should be inseparable. Let us therefore consider what is the best method by which to attack these problems. There are two ways, at least, namely the application of scientific theory as such, the other a matter of trial and error, which latter may or may not be, conducted along scientific lines. The former results from consideration of the problem in the office and the laboratory, the other by means of a works study. The most efficient method to pursue is a combination of both systems. Too great a detailed study of the purely scientific is apt to lead to the recommendation of a line of action that cannot be applied under the conditions pertaining in the factory. On the other hand, the spending of day after day in the works, coupled with a neglect of reading up on the matter, means frequently that the observer gets so bothered and worried by the unsatisfactory condition of things that he is not in the frame of mind to coolly size up the situation, or to develop some possible clue to its fullest extent. One needs to take some days or hours off, depending upon the magnitude of the problem, in which to make all the logical deductions possible from the facts known.

A common error in attempting to work out a problem is to vary several factors at once, such as time, temperature, dilution, composition or what not, whereas the reasonable and more certain procedure is to never vary more than one factor at a time, This may or may not take longer, but it is undoubtedly more certain. It may help the chemist or chemical engineer to appreciate the foregoing if he imagines for the time being, that he is blind, that he has the knowledge of chemistry obtained by his university training, and is facing a factory problem, having to depend on the data supplied by others. Under such circumstances what data would he call for? Has this data been provided?

It has been frequently borne in on me that many a difficulty, chemical and otherwise, can be solved from the office desk by logical deductions from a few, it may be, very simple facts. This side of the works chemist's brain needs constant development, nor will the plant be found wanting in the supplying of material upon which to work.

**Library and Periodicals**

Reference was made at the beginning of this address to the need of looking up the bibliography of the subject in hand. This pre-supposes either a library or access to one. Associated with this is the subscribing to current periodicals. To get the most out of monthly or bi-monthly papers, it is desirable to subscribe for both the individual numbers and the indexed annual volume. The former keep one in touch with the latest developments of one's industry and may be dissected for filing purposes, and the latter form a record which is handier for reference. Although strictly scientific reading matter should not be neglected, yet considerable attention should be given to trade journals. The questions and answers which form a special section of such publications frequently contain much sound advice, and when coupled with scientific training may be used to great advantage.

**Indexing of Analyses**

The making of proper provision for filing and indexing books and papers is naturally most important. In this connection one should bear in mind the value of the routine analyses. These will often give valuable information as to the variation in the purity of trade materials, the characteristic impurities of each source of the same kind of material, etc., so that the chemist is able, after studying a long series of such figures, to state what is the source of some given lot by the analysis alone. The acquisition of such knowledge may be of the greatest use in chemico-legal work, which class of work will come to most chemists sooner or later. To get the most out of the routine work referred to means that all analyses must be card-indexed as to material and cross-indexed as to name of seller, etc. The simpler the system used the better; the main thing is to see that once such an indexing arrangement is started it is kept up-to-date.

If one admits the *raison d' etre* of a library to be its direct and practical utility in helping in the solution of works problems, then one must pay serious attention to its development.

**Cultivation of Acquaintances**

If, however, the collection of books and written material is beneficial, how much more the development of a friendly relationship with one's *confreres*, both in the chemical and commercial world. One of the easiest ways of starting a *human reference library* is to join the leading organizations connected with your profession and the business in which your company is engaged. Further, if you are to use your membership to the best advantage, you must be willing to take an active and constructional part in their activities, nor need you count time expended in such work as purely philanthropic, for, as has been suggested, real and tangible benefits will accrue to yourself.

I would take the liberty of urging you to concentrate on the local and Canadian organizations first, for it is from these that your greatest help should come, and to whom you owe your first support.

**Conventions**

Most organizations, particularly here and in the United States, make a strong feature of conventions. In this they are, in my opinion, wise, for rightly conducted and entered into in the right spirit, participation in such gatherings is undoubtedly a grand incentive. That the benefits of such meetings to those who attend them are real is evidenced by the encouragement given them by an ever-increasing number of companies, both large and small. One goes to a convention, not so much to see exhibits as to obtain ideas from the experts who are in attendance—*not primarily to hear papers, but to meet men.*

It must, of course, be conceded that in order to derive benefits from others we must be equally willing to bestow such knowledge as we ourselves possess.

**Purchasing of Machinery**

A visit to a convention generally results in one's being tempted to purchase or recommend the purchase of at least one piece of works machinery. In this connection, it is well to heed the warning, "Go slowly." Of course, the chemist is often called upon by his company to recommend new equipment for the works. It is noteworthy that in many cases, purchasing agents, superintendents and others frequently order machinery that fails miserably to meet the demands made upon it. Careful attention to the following points will reduce the chances of error:

In the first place get accurate data as to the amount of material to be treated in a given time.

Then remember that two machines doing the work of one may often be best on account of the provision this makes for continuous operation in the event of the breakdown of either.

Bear in mind that first cost is not the only criterion and that the operating cost must include not only power and labor, but also repairs.

**Purchase of Equipment**

If at all possible, and even at considerable expense, have a working sample of the product you intend treating tested out by the makers of the equipment in the machine the purchase of which is contemplated. Attention to this point alone will save many a misunderstanding between the supplier and the purchaser.

In the recommendation of new equipment it is an advantage to give reasons in terms of earning power and, in your estimate of the cost, provide for a good article with all its necessary adjuncts and with special emphasis on suitable housing accommodation, working space and cost of upkeep.

Many, or in fact, most of the suggestions of this paper, may seem self-evident and hackneyed, yet it has been my experience that such matters are often overlooked by the untried chemist or engineer and even for that matter by those whose length of service should warrant greater efficiency.

As the chemical graduate develops so will he probably tend to more executive and less detailed work. Here one of his first duties is to develop a sense of responsibility in others. A man's usefulness depends not so much in what he can accomplish by his own efforts as it does on the extent to which he can develop in others the technical or executive ability and thus be the prime mover of many productive workers, rather than of himself alone.

## POWER-PLANT INSTRUMENTS AND METERS *

N opening his address, Mr. Bailey pointed out that the metering of electricity was a comparatively simple matter compared with the metering of fluids. Fluid meters had been developed only comparatively recently. The reasons for their development are twofold. In the first place, great economy was to be effected by having immediately at hand exact knowledge of the conditions prevailing in all parts of the power-plant. In the second place there was competition between the manufacturers of power-plant instruments which furthered their development.

Venturi meters have long been used by the hydraulic engineer, and were first used in the steam power-plant for measuring feed-water. Later, rate meters were devised for masuring high pressure and exhaust steam, gases, oil, etc., also stoker speed.

Electrical energy is developed in the great centres of population by large steam turbines requiring immense amounts of steam. It takes one to two hours to bring some turbines up to speed. This must be done very gradually. It is therefore necessary that accurate means be provided for determining this speed, in order that the speeding-up may take place without fluctuation. The speaker said that in his opinion there were more turbine failures than the average engineer was aware of. The manufacturer blamed the operator for not taking proper precautions in bringing up to speed. The operator blamed the manufacturer for poor turbine design.

Mr. Bailey then spoke briefly of the average power-plant test. Generally it was of but a few hours' duration and yielded results of no great value. The efficiency obtained over months of operation was the important factor to be considered. The average boiler test was usually like a horse race. All conditions were made as favorable as possible for the test or for the race, and the maximum output and highest efficiency found for that particular period. Such results may be all right, and may have their place, but all-year-round efficiency was of greater importance.

Mr. Bailey has for some years focused his attention on combustion, paying particular attention to the condition of the fire. It is here, he said, that the greatest financial losses of the power plant occur. Coal is money and through the inefficient burning of coal great loss is incurred which might otherwise be avoided.

Mr. Bailey explained certain principles upon which meters depended for their usefulness. Heat lost up the chimney varied, depending upon the amount of air burned. Too little air caused losses through the formation of CO, resulting from unburned gases and poor combustion. On the other hand, an excess amount of air also caused losses due to the heat absorbed by this unnecessary air. There is therefore a happy medium, giving

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*Synopsis of address by E. G. Bailey, President of the Bailey Meter Co., Cleveland, before the M. and E. Club, February 18th, 1921.

minimum chimney losses. It must of necessity be determined for each boiler. Hence we may say that for each particular boiler installation there is a certain weight of coal to be burned with a certain weight of air in order to produce the best results. When this amount of air combines with the available hydrogen and carbon in the fuel, a definite amount of heat is produced. We may therefore speak of the heat produced per pound of air. When this heat is produced and properly absorbed by an efficient boiler, a certain amount of steam is provided. We may, therefore, rate the amount of steam produced to the amount of air used for the combustion, and so obtain a very reliable indication of the efficiency of the combustion taking place in the furnace.

This relation can be visualized on a meter by arranging two pens, the one recording steam flow, the other recording air flow. The steam flow can be measured by inserting an orifice in the steam pipe and arranging a suitable differential pressure gauge. The air flow can be measured also by a differential pressure gauge, the boiler passes acting the same as an orifice.

When the relation between the air flow and the steam flow is correct, the air flow reading is 1.00. For an excess of air the reading would be greater than 1.00 This would mean that there were holes in the fire-bed or that the fire was too thin. This condition can be remedied by the fireman, so that the air will come in proper contact with the coal and produce its full quota of heat. On the other hand, for too little air the reading would be less than 1.00 and would mean that the fire was too thick, and that there was a loss due to unburned gases.

It is therefore up to the fireman to see that the dampers are so manipulated as to burn the right quantity of air for a given steam output.

A meter has also been devised to show the rate of stoker feed, and, hence, the rate of coal consumption. This, of course, should synchronize with the steam flow and the flow of air.

* * *

## Heard in Machine Design.

Shortt—Are you using an English Channel, Staff?

Stafford—No, a Behring Strait. (bearing straight.)

Turn on the $H_2O$.

# PROUD, ALOOF, WHITE COAL WILL NOT OUST MEEK GAS *

## Feeling Grows that Electrical Energy Should be Used for Power Purposes Only—The Gas Industry Making Great Strides in Competition with its Electrical Brother.

THAT gas is only lately coming into its own, goes without saying with those who know the situation, and a few extracts from reports of eminent authorities may be of interest at this time in this connection.

That gas for illuminating purposes has not as promising a future as electricity is granted, but still there are thousands, and hundreds of thousands of homes throughout the country that will be for a long time to come the best users of gas for this purpose, because of the fact that there is not yet, and will not be for some time, if ever, sufficient electrical energy available to supply the many local requirements.

The gas industry has made remarkable strides during the past ten years. It is gaining steadily notwithstanding the tremendous publicity given to the development of its competitor—electrical energy— and to the wonderful extension of the Hydro Electric Power Commission's work in Ontario. Men who know are beginning to realize that the electrical power plants now in operation, and contemplated, will never be able to supply the ultimate demand that will be made for power in Ontario alone. Electricity for baking, ironing, and other purposes, is no longer an experiment, but would be an admitted success as far as doing the work is concerned, if it were not for the fact that the use of electricity, for such purposes is nothing short of a national crime, and especially will this be so in the future, when one considers the same energy will do 25, 50 and in some cases 100 per cent. more useful work if used as a motive power. Many people are looking forward to the days when electricity will supplant the use of coal and gas for fuels in the heating of their homes, and for doing many other heating operations. But, using the words of a well-known gentleman in the person of Mr. Arthur V. White, Consulting Engineer of the Commission of Conservation, that "The sooner the public mind is disabused of the idea that, as a heating agent, electrical energy can be made an adequate substitute for coal for the thousands of Canadian homes, the better it will be for it." He states that its economical use is in the direction of the development of power. In referring to this same gentleman, an editorial published in the April 1918 *Industrial Canada*, on electrical heating, states that, "It will doubtless come as a surprise to many that in the opinion of so able an engineer as

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*Being a digest of a Lecture given by G. W. ALLEN, Educational Director of the Consumers' Gas Co., of Toronto, delivered before the Metallurgical and Mining Club, University of Toronto, January 28th, 1921.

Mr. Arthur V. White, of the Conservation Commission, the application of electrical energy in the production of heat, is a very much exaggerated possibility. We have for some time, had a sort of pleasing feeling that, sooner or later means would be devised for the economic utilization of the electric current in heating houses.

"The fear that the coal supply would be exhausted within a certain number of years was offset by the belief that long before that time we would have become quite independent of coal. Mr. White, of course, does not say that means will not be found to produce a suitable substitute for coal, but the point is that we should not rely on "our water powers to do the trick." There will be adequate for power purposes, but not for heating purposes, and until some other source of electrical energy is discovered, we must do our best with the present arrangements."

At one of the meetings of the Civil Engineers held in Toronto in 1918, it was quite clearly shown from a digest made of the papers read at those meetings, and from the discussion that took place between the Engineers representing every branch of the fuel industry, that electricity was doing the country a great service whenever it was utilized for power purposes, but when used as a heating agent, was doing the country a national injustice.

In recent years there have been many meetings that tended to give the gas men on the other hand great encouragement as to the future of their industry. That gas will play a very important part in the future of this and other countries has been clearly proven, of late, especially when we review the great progress made in modern carbonization processes.

To show what an important place the gas industry holds in the country's economic problems, would say, that in the U. S. alone, there have been constructed during the past few years, over 5,000 coke oven plants producing high-class coke for metallurgical, foundry and domestic purposes, and incidentally, large quantities of gas, and other by-products, the total value of which reached, I understand, for last year, to the enormous sum of $300,000,000.

It is being realized more than ever, that coals of all kinds should be put through a carbonization process, thereby obtaining a high degree of efficiency in the return of valuable constituents, rather than wasting a high percentage of its efficiency by burning or consuming same in its raw state directly under boilers and other heating equipment. And so with utilizing electrical energy as a heat producer we find that great losses were sustained by transforming the electrical energy into heating energy, and this is very strikingly manifested when one considers the great amount of energy required to develop a comparatively small amount of heat on the B.T.U. basis per K.W.H.

A simple illustration of this is shown by the amount of energy it takes to operate an ordinary 6 lb. electric iron, commonly used in the homes of the people. One of these irons requires as much energy to operate as would be required to light up twenty-four 25-watt tungsten lamps, or sufficient to run approximately 16 sewing-machines simultaneously. My belief is that it would be far better to have this energy devoted to power uses only, than to waste it in heat-producing appliances. Again, if all possible energy was developed by harnessing every waterfall in Ontario, and utilized for heating purposes only, there would not be enough heat generated to warm even a small percentage of the homes, say in Western Ontario.

There is great demand for electric current for power purposes, and as I understand it, in normal times, everyone of the 247 odd municipalities in Western Ontario, who depend upon Hydro Electric power, are considerably short of the amount required to take care of ordinary demands, let alone the demand that will be created for power within the next ten years. Then again, there is the Hydro radial development schemes which will require a large amount of power for operation purposes, and when one considers the present shortage coupled with the demand that will be made in the near future, it can hardly be expected that the energy to be developed at Niagara Falls through the Chippawa Creek scheme, or other developments, can take care of the ultimate demand.

Personally, I believe the steam railroads in Western Ontario should be electrified, and if such is to happen, we will require all the energy we can possibly gather together to take care of such loads, let alone that also required in other industries. The changing over of the steam railroads to electric power will, on the other hand, release large quantities of coal for use in gas development in the future, and although most of such coals are not considered good for coking purposes, still when properly combined with good coking coals, answers the purpose for gas, coke and by-product developments admirably.

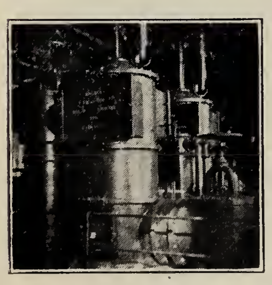
It is not the present time I am mainly considering, but the future development of both gas and electricity in this country, and anything that can be done to place the gas and electrical industries on an efficiency basis, will be well rewarded.

To give you an example of the gas development and progress, even in the midst of the cheapest electrical competition, almost in the world, I would point to the work developed by the Consumers' Gas Co., of Toronto. At the beginning of the Toronto Hydro Electric development work, this company, although at that time it had been 61 years in business, decided to establish a New Business Department for the purpose of educating the people on how to get the greatest use out of its gas in return for the amount of money expended. It felt that if the

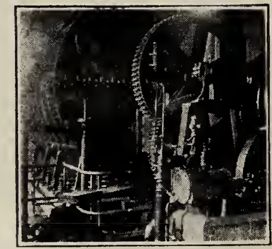
Modern Coal Gas Benches, Showing Mouth-pieces of Horizontal Retorts. Coal Charging Machine Also Shown.

Old Method of Placing Coal in Retorts in Large Gas Works.

Coke Discharging from Retort. Pushed Out From Other Side by Discharging Machine

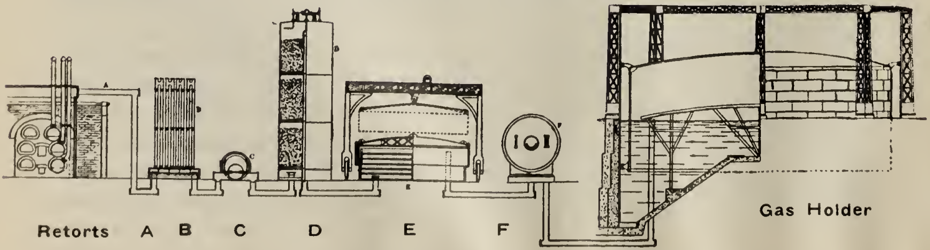


Pressure Regulating House



Machines for Washing and Scrubbing the Gas

Tar Removing Apparatuss



A Sectional Drawing of Coal Gas Works

people understood the proper use of gas, and if the Company taught them how to use it more efficiently, it would be an effort worth while. That was ten years ago, and the Company had at that time approximately 55,000 consumers, but which, in the face of the competition mentioned, has increased this number to 123,000 at the present moment—"more consumers of gas, I understand, than the city itself has water customers." The output of gas has also increased from an average of around five million cubic feet daily to nearly fifteen million cubic feet daily, and on some of the cold days of the winter, the output has reached close to seventeen million cubic feet.

The Company uses approximately 800 tons of coal daily, but putting this coal through the carbonization process results in the Company doing more with the coal for the benefit of its 123,000 consumers than would result from its use in any other way.

The speaker's own opinion regarding the solution of the fuel problem of the future is in the greater conservation of our fuel resources through the carbonization of the coal, and believes that no coal should be used in its raw state for heating purposes, when there are other sources of fuel supply such as wood fuel on farms, etc., and no coal whatever should be allowed to be shipped to centres where there is an abundant wood supply. Coal brought into the country, or mined in the country, should be turned over to gas manufacturing or coke oven plants where the gas content would be released and sold for such heating purposes as it could efficiently take care of. It would also be distributed in as large an area as possible for domestic, industrial and other heating purposes, at a low price, while the coke residual could be used in the centres not conveniently situated to the coal or wood supply or gas company, and also utilized in metallurgical, foundry and smelter operations, and if necessary, for the generation of steam power.

It may be interesting to this audience to go through a modern gas plant, and in order to make it interesting I have prepared a number of slides which illustrate the process from the earliest times to the present moment, and it will also enable each one of us to see what great strides have taken place in this industry within recent years.

We have here a portrait of Murdock, one of the earliest investigators we know of in the distillation of coal. He was born in Auchinleck, Ayrshire, Scotland, in 1754, and when quite young experimented in the carbonization of coal. Most of us know, or have heard of this clay pipe experiment, and many of the younger generation of the present day, have tried this scheme for producing gas on a small scale. Even in our modern plants, the principles involved in gas production, through means of coal placed in the clay pipe and sealed up, are carried on at the present time. The bowl represents the retort or receptacle in which the soft coal is hermetically sealed, and after this simple contrivance is placed in a coal fire it will not be long before the gas will begin to rise up the stem of the pipe, which in modern practice would be termed the ascension pipe. I will briefly explain some of the views as we go along.

This view shows Murdoch walking home through the streets of Redruth, Cornwall, carrying a bladder full of gas under his arm. With a burner on the top end he is seen illuminating his way home through the darkness after leaving the works daily.

Here we have the first house to be lighted with coal gas. It is Wm. Murdoch's house at Redruth, which was first lighted in 1792, and which is still in use.

Here we have the portrait of Lebon the Frenchman, who is to be given credit along with Murdoch for his early discoveries in gas making. He did not, however, publically demonstrate his inventions until ten years after Murdoch had lighted his home with coal gas in Redruth.

This is Minckelers—,the Holland Chemist, another eminent man who, report has it, lighted his lecture room with coal gas in 1785.

Coming down a little later, we here see some of the old lamp posts used during the early days of gas-lighting in London, Eng. Gas was then burned in its unpurified state with the results as shown.

Coming to America, we find the first gas light company established at Baltimore in 1816.

An early coal gas plant is shown in the next illustration, and is that as taken from Parke's Chemical Catechism, published in 1810, but with gas, as with most other things, there was no royal road to success. Little was known of its properties and many requirements, as for example, the method of measuring the gas. In the early days the consumers were charged so much an hour, or so much per burner, for the gas they used, but these methods proved unsatisfactory, and it was necessary to have one of the gas company's men go out and tap at the window where the number of hours bargained for had been exceeded, and tap at the window and ask that the light be put out, otherwise the company would send in a larger bill the following month.

A meter, however, was brought out a few years later, by a gentleman named Samuel Clegg, who, like Murdoch, was engaged at the Watt & Soho Works, Birmingham. A picture of Clegg's meter, for it was he who invented the gas meter, is here shown. In the illustration of the early gas works previously shown on the screen we see two essentials in the manufacture of gas as carried on to-day. First, the coal is roasted or distilled in a closed vessel surrounded with heat; second, it is stored over water in the gas holders, but apart from this, how crude was the process.

Beyond the tub, or similar receptacle, to catch the coal, tar and ammonia water, nothing intervened between the retort and the holder.

We may leave off the intervening years with their turmoil and strife and look at the method of manufacture in use at the present time.

One of the first essentials is that the gas works be within reach of a carrying system, as coal is chiefly conveyed by rail, and the works must be constructed at a railway depot or siding. In our works the railway siding runs right into the yards of the gas works, and the coal is stored convenient to the retort or carbonization house. In the average works there must be:—

(*a*) Coal storage facilities.

(*b*) Retorts to distil the coal in.

(*c*) Condenser to cool crude gas.

(*d*) Scrubbers to take out ammonia and some other impurities.

(*e*) Purifiers to take out sulphuretted hydrogen, carbonic acid, carbon bi-sulphide, and other sulphur compounds.

(*e*) Meter to register gas made.

(*g*) Gas holder to store the gas.

Coal is first put into the retort (*b*) and immediately sealed up by placing the lid on the mouthpiece. The joint of the lid with the mouthpiece is made tight by having planed faces which are self-sealing, or by using a lime paste. The retorts are made of silica, fire clay, and usually last about three years. The illustrations are those of what are termed horizontal retorts. These are equipped with openings and doors at either end, thus allowing the coal to be placed in at one end, and when carbonized the residual coke can be pushed clear through from one end to the other.

Here we have the elevation of a retort bench. A bench of retorts contains usually more than one retort. In some works as many as 12 are heated with one furnace. In the illustration there are seven retorts. The heat is caused to circulate evenly round the retorts so as to keep them at a temperature of about 2,000 degrees Fahrenheit, and the products of combustion are carried away through the flue to the chimney. In small gas works the operation is usually carried on by one man, and the illustrations show the man carrying out the three processes of charging, drawing, and clinkering. Here we have him putting coal into the retort; in the second, he is drawing out the coke after all the gas has been taken from the coal. (It usually takes about eight hours to get all the gas required from the coal.) Here he is shown attending to the arduous job of cleaning out the fire which heats the retorts. If the heats are right nothing will be left in the retort but coke after the eight hour period. Some of this is used for the generator furnace, and the rest is deposited in the yard for sale.

While the coal is being roasted, the gas, together with the tar, and water, in the form of vapor, passes up the ascension pipe, each retort having its own separate pipe. From the ascension pipe it reaches the hydraulic main which is the large pipe placed along the top of all the retort benches. It is partially filled with water, into which the ascension pipe, after passing over the bridge, and turning over in the shape of a "U," dips slightly, and serves the purpose of allowing the gas to pass freely forward, when the retorts are closed, but prevents it from returning when they are open again for the purpose of putting in a sufficient supply of coal. From the hydraulic main the gas passes to the condensors where the gas is cooled sufficient to allow the tarry vapors to change from vapor to liquid, and this tarry matter is collected in wells underneath the condensors. The illustration on the screen gives a very good idea of what these condensors look like.

The next piece of apparatus is known as the exhauster. This machine performs two principal functions. It withdraws the gas from the retorts as quickly as possible, and also overcomes the resistance which the remainder of the gas-making plant offers to the flow of the gas. The speed of the machine is carefully governed. One of the chief impurities in the gas at this stage is ammonia, and special means are used for extracting it.

Ammonia is extremely soluble in water, for the latter will absorb at ordinary temperature over 700 times its own volume of the ammonia gas. When the coal gas leaves the exhauster it is conducted through what we term the scrubber,—in many works this is a cylindrical tower filled with coke or thin boards set on edge in tiers. The coke or boards are kept saturated with water which is pumped or otherwise delivered to the top of the scrubber. The gas enters at the bottom passing upwards and out at the top. The water is distributed by means of liquor turbine, a mechanical means for spreading the water so that trickling down through the coke or boards, it is brought into close contact with the finely divided streams of coal gas going in the opposite direction. The result is that the ammonia leaves the gas and joins the water. The affluent liquid is known as ammoniacal liquor, and valuable by-products are derived from it. Some companies have a different form of scrubber in that the gas is allowed to bubble up through a large body of water, and in this way be cleansed from its ammonia content, and also some of the tarry products. Rotary washer scrubbers are used in many large works for the express purpose of making sure that all traces of ammonia have been extracted from the gas.

When the gas left the retort it contained tar as a vapor, ammonia as a gas, sulphur in the form of sulphuretted hydrogen, carbon bi-sulphide, and other forms of carbonic acid gas. There are other impurities, but they are of minor importance.

There should now be no tar or ammonia left, but there will be a considerable amount of sulphur in various forms, and carbonic acid. These are removed by a process called purification. The apparatus is illustrated on the screen, and consists of a series of cast-iron boxes. Inside each box are placed layers of bog ore, chemically known as oxide of iron, which takes out the sulphur whilst the gas is passing through it. The gas is now taken to the meter house where the amount manufactured is measured, and from thence to the gas holders, a number of styles of which are shown here.

As the gas enters, the holder rises, except when more gas is being used than is made, when it lowers.

From the gas holder the gas leaves the works to the gas consumers, but before doing so directly, its pressure is gauged by means of a governor which automatically maintains an even pressure on the city mains.

We have now produced through this process, 10 to 12 thousand cubic feet of gas per ton, approximately 60 per cent. of the original weight of the coal, about five pounds of concentrated ammonia, and 10 to 15 gallons of tar, from each ton. These products in themselves when efficiently developed return to a tremendous number of various by-products.

The next few illustrations will show a few well-known products, and the other illustrations that are to follow will give some idea of the great strides made in the gas industry.

There are at the present time over 1,000 uses for gas in the industries of Toronto alone, and the local Company has only touched the fringe of the possible business obtainable from this source. Time does not permit to list these processes, but at another time an opportunity might be presented of showing what is being done in this direction.

# FIRE PREVENTION

By W. L. Clairmont, '22.

FROM the beginning of time fire has played a most important role in the world's evolution. It has made and unmade continents, it has been used to generate power, and with it nine-tenths of our food is prepared. Properly controlled, it is our most important ally, but unharnessed and uncontrolled, it can destroy, and has destroyed, in one hour, what nature has taken centuries to create, or what man has spent years in fashioning. How, then, can it be prevented?

Fire prevention is a question that vitally interests every Canadian, man woman or child, and we in Ontario should lead the way, both by word and deed, in furthering it. How many go to bed at night little thinking that the next day will find them mourning some of their loved ones, done to death by the dread fiend, fire? Mr. George F. Lewis, Deputy Fire Marshal of Ontario, states that the estimated death toll on the North American Continent from this cause is 30,000 human beings yearly. Again, how many people are enjoying good, comfortable homes to-night who to-morrow will be homeless? Statistics show that over 6,000 fires occure yearly in the homes of Ontario people, involving in the aggregate a huge financial loss. For the North American Continent, this loss totals up to three hundred and fifty millions of dollars annually.

## What Fire Prevention Involves

In fire prevention there is involved everything pertaining to the science of constructing, protecting and occupying buildings so as to minimize the danger of fire. It must not be confused with the narrower definition of fire-protection," applied to the mechanical aids employed to discover, resist and fight fire. For the present purposes we shall consider fire prevention under six heads, (1) in the community as a whole, (2) in the home, (3) in the factory, (4) in the business section of our towns and cities, (5) in the forest, and (6) prevention of fires caused by lightning. Only the most important will be touched upon here.

## Educating the Community.

The community has been considered first, rather than the home, since if a fire occurs in a community, not only one's home is in danger, but also those of many other people. What is needed first in the community is an educational campaign, for by means of it there may be brought before the minds of the people the appalling disasters that have occurred, and will recur, if steps are not taken to prevent them. For such work there are many educational facilities at hand, such as the press and public speakers. Continual repetition of cautions will ultimately result in the formation of good habits. In this matter the Ontario Fire Prevention League is doing pioneer work, and their brochure entitled "Conservation of Life and Property," if widely distributed and digested, should be the means of saving many lives and thousands of dollars annually. The facts must be made generally known to arouse sufficient interest among its individual citizens to induce them to study the subject, and, as far as possible, to apply the knowledge in their homes. Such information as a list of fires in neighboring towns, records of fire insurance organizations, statistics on the subject by journals continually publishing such facts could all be given a wide distribution by means of circulars. Could not legislation be enacted whereby in the case of fire, if it were found that it had been caused by gross carelessness of the owner, he be made to pay the cost of extinguishing it? He would soon learn to be more careful where he puts his hot ashes, or where he piles his kindling wood at night. In the Napoleonic code—still the fire insurance laws of France—it is provided that an individual must in a measure insure his neighbor as well as himself. This tends to induce more caution, by trying to keep down the fire hazard, and consequently the rates. Many fires are due to the carelessness and selfishness of property owners in our towns and cities, and if public opinion were organized, Legislative Assemblies would not have much trouble in enacting satisfactory laws. Control of Canadian fire waste must come from a careful study of the existing laws in each Province, city and town, followed by the enactment and enforcement of proper legislation to correct bad conditions.

## Ontario Fire Losses

Let us compare the per capita fire-loss in Ontario with that in the principal European countries. In Ontario it is $5.00 per annum, while in the principal European countries it is in the neighborhood of 33 cents! What is the cause of this great disparity? The conditions that appear to cause this difference are (1) the larger use of non-combustible materials, due no doubt to the high cost of wood, (2) the stricter observance of better building codes, (3) lower heights and smaller areas employed in city construction, and (4) finally the intangible influence of their older civilization, which makes for greater care in saving and in all their affairs. If a remedy for our great fire-loss lies here, then why not educate ourselves along similar lines?

## Fire Prevention in the Home

In the home, cleanliness of the house and surroundings is the most potent factor in preventing fires. The old adage, "An ounce of prevention is worth a pound of cure," applies in this connection as in sickness. Those who have lived in rural Ontario towns remember the spring house-cleanings and yard-cleanings, when the house and yard were gone over thoroughly, and the accumulations of the thousand and one odd things were cleaned out, put in a big pile and burned or else sold to the rag-man.

That was good, but suppose a fire had started before the cleaning-out period. In many cases the useless articles piled away in the cellar or attic would have been the cause of it. It is thus best to keep such articles down to a minimum. Matches should never be put away with the old clothes thus stored.

With regard to matches, the only safe kind to keep around the house are those that ignite only on the prepared surface of the containing box. They should by all means be kept away from small children, rats and mice. It may not be generally known that these latter pests have been suspected of starting a good many fires, as they nibble the ends of the matches to get at the phosphorus contained therein. They have also been known to carry away matches to their nests, which, for the sake of comfort, they build near chimneys or hot-water pipes. The matches become heated on account of their proximity to the chimney, and ignite. The moral is to get rid of rats and mice. Fires often occur, too, from careless smokers throwing away matches without seeing that they are entirely extinct. It is hard to gauge just what damage has been caused by this act, but it should be regarded as a criminal offense.

Other common bad habits that often create fires are, throwing hot ashes into wooden receptacles, using coal oil to start fires, filling oil lamps at night, leaving chimneys and stove-pipes too long without cleaning, and leaving lighted lanterns in dangerous places. Persons indulging in such practices should be forcibly impressed with the fact that they are flirting with fire.

## The Factory Hazard

In the factory, too, we must always be on our guard, for if it is burned down, the means of earning a livelihood vanish for a good many people. Very often a fire in a factory affects a whole community, and much hardship and suffering are undergone when men are thus suddenly thrown out of work. Not only that, but the hazard to life is much greater than in a single house, for here are sometimes gathered thousands of people. Here it is that the greatest cleanliness should prevail. Much good would result if employers were to put up signs in their factories, where everybody could see them, to the effect that "Fire in this plant will put every man out of work. Guard the property and save your position." The employees would then be constantly on their guard, having always before them the idea of the dire consequences resulting from a fire. Especially should there be no accumulations of oily waste, for spontaneous combustion from such causes has been frequently known to occur. The greatest care should be taken to get rid of as much dust as possible, more especially in grain elevators and flour mills, for the rapid oxidization of the finely divided suspended matter in these industries has caused fearful explosions under certain conditions, such as a spark from an electric motor or a slipping belt. Once more, the necessity for cleanliness is strikingly illustrated. Mechanical dust collectors should be provided where processes generate fine dust, as in the manufacture of starch, flour, coal, cork, grain-dust, etc. Chemical works and explosive works should be far removed from a congested area, in order to reduce to a minimum the danger in case a fire takes place. Smoking in factories should be absolutely forbidden. Another danger that lurks in the factory is the careless putting away in closets of tinsmiths' fire-pots, charcoal-furnaces, etc., before cooling.

Working over-hours is also a powerful factor in the destruction of factories, for it produces a sleep indifference on the part of the tired workman. Many fires have been observed by passers-by in buildings where workmen were oblivious to the fact, owing to their tired condition. So it would seem a wise thing, where much extra work was to be done, to put on another shift.

## Fire Prevention in the Business District

The business district, being usually the most congested area in any town or city, possesses peculiar hazards. It is possible to walk up any of the business streets of the principal cities and towns of Ontario and see grotesque and irregular roof lines in the different blocks. Such not only cast a reflection on our artistic abilities, but a very great danger in time of fire, being, in many cases, a veritable fire-trap. Drastic changes in our building laws should be resorted to in order to remove this defect. In Paris often one may see block upon block of buildings of an even height, which not only is pleasing to the eye, but is a great help to firemen in fire-fighting operations.

Every building should be fire-proof as far as possible. It is, of course, impossible to make them entirely fire-proof, as witness the results in the great Baltimore and San Francisco fires, where skyscrapers, considered well-nigh fireproof, were gutted. Architects and engineers by specifying the most non-combustible materials for building construction, can greatly aid in reducing our enormous fire-loss.

The carelessness of tradesmen in leaving empty packing boxes, etc., under the grating in sidewalks has been responsible for many fires. The practice is dangerous, for at any instant a careless smoker may drop a cigarette butt or a lighted match through the grating, and a conflagration results. In the storing away of volatile and dangerous compounds, care must be taken not to exceed the lawful amount, for example in the storage of calcium carbide. The sweepings of a floor, following the storing of slaked lime in barrels, and particularly if the floor has been damp, should be carried outside and not put in receptacles inside, for the slaked lime when in contact with water generates an enormous amount of heat. Again, too much care cannot be taken in the storing of oils, bituminous coal, lampblack, charcoal, and even tracing paper. A can or a barrel of oil should never be kept in the same room with a furnace or stove. As for gasoline, it should be stored in underground iron tanks, away from any building.

### Forest Fires

As yet nothing has been said of forest fires. Everyone who has lived in Northern Ontario knows of these dread, almost annual, recurrences, and those who have not have been impressed with their extent by the accounts in newspapers. The problem of conserving our natural resources is receiving much attention of late, and should receive more. Our forests are being depleted at an alarmingly increasing rate with no provision—or practically none—being made for their replacement, and it is incumbent upon us to exercise all the diligence and precaution possible in guarding them from fires. A few years ago locomotives were blamed for setting forests on fire, due to the sparks from the smokestack falling upon the underbrush in the dry summer season. This danger has now been largely removed by the employment of effective spark screens. But why should lumber and pulp companies be allowed to leave a bush in the state of a playground for the wandering spark? Legislation should be enacted to prohibit wanton negligence of this kind.

Settlers also cannot escape responsibility for forest fires, for in clearing up land, they build huge fires, which work their way underground and smoulder for a month or so, and then suddenly burst out in an entirely different locality. Careless campers have also caused huge forest conflagrations by not properly extinguishing their fires or by dropping a lighted match amongst the dry tinder. Before leaving, the camper should see that the fire is absolutely out. Then, too, they should be built in a suitable place, not close to trees or underbrush, and should not be covered with leaves, dry grass or moss.

### Lightning Fires

Lightning has caused more fires than one would imagine. For example, in 1919, there were 1,104 lightning fires in all classes of buildings in Ontario, causing a total loss of $506,907. These fires largely occurred on farms and could have been prevented by the efficient installation of lightning rods. It has been demonstrated that where these rods were properly installed, an efficiency of 99 per cent. has been obtained.

We have now seen the numerous ways in which fires can occur and the equally numerous ways in which they can be prevented. The main point to keep in mind is the elimination of ignorance, carelessness and filth by a publicity campaign. Witness the great results obtained in the good roads movement by constantly keeping before the public the need of such highways. Is it too much to hope that the same results could be obtained along the lines of fire prevention by educating the public and forming a strong public opinion in its favor?

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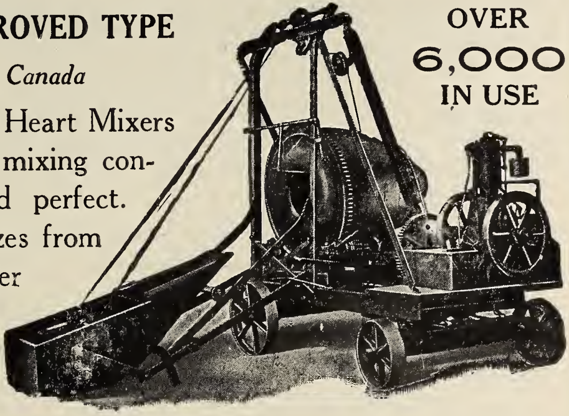

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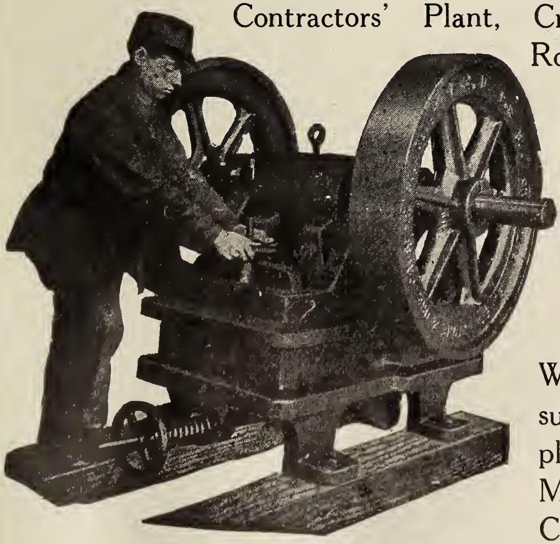

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# Transactions and Year Book
OF
# The University of Toronto Engineering Society
WITH WHICH IS INCORPORATED "APPLIED SCIENCE"
PUBLISHED ANNUALLY BY THE SOCIETY

No. 34 TORONTO, APRIL 15, 1921 1920-21

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## EDITORIAL

Owing to the fact that this publication goes to press before the books are closed for the year, it has not been possible to publish the Auditors' report. However, the first or Freshman issue of the *Toike Oike* will contain this in full. Mr. Ferguson, who has audited the books of the Society for the past six years, may be numbered as one of the Society's real friends. In the days of our financial difficulties his advice was invaluable, and it is only since the improvement in our finances that he has consented to accept his fee. His comment on the work of the year will be well worth your perusal.

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# A TRIBUTE TO THE LATE DR. WILLIAM HODGSON ELLIS

By James Watson Bain

ON August 23, 1920, the University of Toronto suffered a severe loss through the death of its distinguished alumnist, William Hodgson Ellis, LL.D., M.A., M.B., Professor Emeritus of Applied Chemistry and Dean of the Faculty of Applied Science and Engineering from 1914 to 1919.

Dr. Ellis was born in Derbyshire, England, in 1845, and during early boyhood his father emigrated to America and settled in Illinois. To this circumstance, Dr. Ellis owed an experience quite unusual among his Canadian contemporaries, for he could clearly recall listening to one of Abraham Lincoln's campaign speeches, which made a profound impression on his youthful mind. After a few years in the United States, the family moved to Toronto, where Dr. Ellis pursued his studies at the University, graduating first in Arts and then in Medicine.

The Professor of Chemistry in the University at that time was Henry Croft, a man of singularly attractive personality, and an excellent teacher. Largely owing to his enthusiasm, Dr. Ellis became his assistant instead of following the profession of medicine, and after a brief period undertook the additional duty of teaching chemistry in the newly-founded School of Technology, which had been formed to supplement and supersede the older Mechanics' Institute.

When the School of Practical Science was instituted, in 1877, to provide for the training of engineers, Dr. Ellis became the Assistant Professor of Chemistry, and shortly afterwards Professor of Applied Chemistry, a title which he retained to the last. In the medical faculty, Dr. Ellis was for many years Professor of Toxicology and Medical Jurisprudence, in which fields he had a very wide experience. In addition, Dr. Ellis lectured to students in the faculties of Arts and Forestry on Applied Chemistry, with the result that he was well known to many graduates other than those of Applied Science.

In the midst of his university activities, Dr. Ellis found time to act as a Public Analyst for the Inland Revenue Department of the Federal Government, and the exprience thus gained gave to his lectures and laboratory instruction that touch of reality which is so potent an agent in arousing and retaining the interest of students.

During the years of professional activity, he was engaged in practically every criminal case in Ontario where expert testimony in medical jurisprudence was necessary. This brought him into contact with the leaders of the legal profession and widened his already large circle of friends. No other circumstances threw into more prominent relief his outstanding qualities than the investigation of some suspected case of poisoning. No pains were too great, no precaution was too trivial to be neglected when the laboratory examination was under way, and in the witness box his evidence was so clear, direct and unmistakable that it was never shaken by counsel.

In the course of his long career, Dr. Ellis was called upon to give advice upon a great variety of matters involving considerations of chemistry, and each of these received a careful and thorough study before an opinion was issued. Long after the matter appeared, in the minds of his assistants, to be definitely settled by laboratory evidence, Dr. Ellis pursued every cross trail until he had thoroughly convinced himself that it led nowhere, which illustrates the dislike of hasty judgments, which was one of his well-known characteristics.

In 1914, the first Dean of the Faculty of Applied Science Dr. John Galbraith, died, and at the request of the President, Dr. Ellis became his successor, although he had already made application to be relieved of duty on account of age. The situation was peculiarly difficult. The former Dean had spent time and energy unsparingly in promoting the interests of the "School," added to which his personal qualities had won for him a host of friends; the war had begun to drain the students from the University, which created new and difficult situations; and there was an insistent call for progress and leadership along new lines of work. It was almost too much to expect from a man of 69, but Dr. Ellis shouldered the load cheerfully, maintained the reputation of the Dean for the prompt despatch of business, guided the Faculty in the perplexing questions of student life under war conditions, and initiated among other things the School of Engineering Research, which has abundantly justified his foresight and energy.

Honors, academic and professional, came to him in abundance. He received the honorary degree, LL.D., from both his Alma Mater and McGill; he served as President of the Canadian Institute and as Chairman of the Canadian Section of Chemical Industry. Shortly before he retired, a dinner was given in his honor at the York Club, and a sheaf of congratulatory telegrams from friends and old students from all over North America was the feature of the evening.

Dr. Ellis was passionately fond of outdoor life and had a wide and intimate knowledge of natural history. While at the University, he visited the Muskoka district, at that time an almost virgin forestland, and having once experienced the charm of the North country, every succeeding summer found his canoe in some part of that noble heritage of the Canadian. He was an ardent fisherman, and took the keenest interest in all the intricacies of the art as practised by Isaak Walton and his disciples; indeed, the Compleat Angler was his familiar companion, from which he would quote at will. The scientific bent of his mind was displayed in this connection in the establishment of an empirical rule by which the weight of a black bass could be deduced by its length, a result obtained graphically from specimens which he himself had caught. On May 1st of each year, Dr. Ellis was not to be found by those who sought his professional services, but the initiated were perfectly aware of the fact that he could be discovered in a boat or canoe, trying a new fly on the trout. It was quite natural, therefore, that he visited such famous fishing grounds as the Nipigon River, the north shore of Lake Superior, the Temagami district and many others, long years in advance of the ordinary tourist, and his recollections of these expeditions interested and entertained his friends on many occasions. That the call came to him at last among the woods and waters which he loved so well has appeared to his many friends as particularly appropriate.

Dr. Ellis was very fond of golf and played at the Toronto Golf Club for many years. He further endeared himself to many of his friends by cheerfully enduring their efforts to learn the game or to attain some proficiency in it. One man was heard to remark, after a round, that only a golfer of unlimited forbearance and sympathy, such as Dr. Ellis, could have watched the novice's play without picking up his ball and going home in disgust.

To be a poet, also, was Dr. Ellis' good fortune, and from his pen we have some delightful accounts of incidents usually drawn from outdoor life. Some of his friends collected these poems and published them privately under the title, "Wayside Weeds," a modest book which is carefully treasured by those who loved the author. That Dr. Ellis could sketch excellently and had a talent for extemporizing rapidly with pen or crayon is well known to all the members of the staff of the university, whose annual dinners were enlivened by a series of drawings executed while the artist made a running explanation. These were always novel and invariably humorous; usually some well known topic of the day was treated in inimitable fashion. The flavor of Dr. Ellis' humor may perhaps be best described by drawing a parallel with Lewis Carroll, and had he found time to do so, he might have enriched our literature with a second Alice in Wonderland.

To set down adequately in black and white an account of those traits of character which made Dr. Ellis so much admired and beloved by his friends is quite beyond the power of the present writer, and a few words must suffice. The kindness and sympathy which never failed remain an undying memory to those who knew him, but no mere amiability prevented him from taking a strong stand, cost what it might.

In one of the difficult situations which arose during the war, he alone was serene and undisturbed among the turmoil which threatened to bring about an ugly crisis. To meet Dr. Ellis was

to carry away the impression of a man with whom one could sit on a log, smoking, and discuss almost any subject whatever; and his capacity for companionship without ceremony was an open sesame to the hearts of nearly every one he met.

During the Fenian Raid, Dr. Ellis went to the Niagara frontier as a member of the University Company, and had the misfortune to be taken prisoner. In later years, he frequently referred to his military experiences with an affectionate touch, which justifies us in quoting from "The Happy Warrior" some lines which describe, with all the aptitude possible in language, the character of him who was recognized not only as the head of his profession in Canada, but also as one of its most powerful influences for good:

Who, with a toward or untoward lot,
Prosperous or adverse, to his wish or not,
Plays, in the many games of life, that one
Where what he most doth value must be won:
Whom neither shape of danger can dismay,
Nor thought of tender happiness betray;
Who, not content that former worth stand fast,
Looks forward, persevering to the last,
From well to better, daily self-surpast."

## ADDRESS OF RETIRING PRESIDENT

IN a moment of mental aberration I approved of the appointment of the Editor of this volume, and, in a spasm of temporary insanity, I remarked that it was customary for the retiring President to make his farewell bow in the shape of a short article. I make the aforesaid apologies because, had the selection been wisely made, the Editor would have accepted my daily postponements in the light that I intended them and go to press without it, but as it is I am so constantly reminded that I am the last contributor to submit my text, that, fully convinced of his complete lack of discretion and utter unfitness for his position I take this occasion to tell him so, and will proceed to inflict myself upon you for the last time.

What to write about, that is the question. They say the title sells the book. Someone suggests "Professors I Have Known." No, it savors too much of Ernest Thompson Seton—"In Lab. and Lecture." Sir Walter Scott succeeded in describing places he had never seen, but I cannot aim so high. Probably I had better confine myself to something with which I am measurably acquainted, so let it be "The Engineering Society."

As the chief executive of the Society I am occasionally asked "Why is the Engineering Society?" I have been accused of taking its affairs too seriously. I am informed that when the present generation passes there will come those who know us not and will not miss us. Much more am I told, but all in the same vein.

Now I have never become comfortably acquainted with a slide rule, and, although I have lost my freshman's awe of the higher mathematics, I am afraid that I cannot call them to my aid. Faithful servants of the lamp though they be to my instructors, they know me not. However, perhaps by rule of thumb I may arrive at a result, and, if my logic be not scanned too closely it may convince.

The aims and objects of the Society are all laid down in the Constitution. This would appear to be the conventional thing to do, and framers of such works would seem to become conventional by virtue of their appointment. To me, however, the essence of the matter is that the Society is a self-governing community. A field in which the embryo engineer may learn two lessons: First, the benefit derived by the members of a community working together as an organized body, and second, the lesson of responsibility. With regard to the first, it is one point which the practicing engineer of to-day realizes as his greatest drawback, and one which they are making every effort to correct. As members of any community there are few men as well qualified to enter into the life and activities as the engineer, and yet there is no profession that is more backward in doing so. The community should not be a Haitian Army, but it needs solid, interested, active material in the ranks and that same material is going to be recognized and represented among the leaders. We have here, therefore, a body who are organized to handle their own affairs, to handle public service institutions, and generally be of the most service to their members, an ideal community.

In the case of the second, at first glance it would seem that some score at most will profit by holding positions of responsibility. There were, however, this year over one hundred and fifty members on Committees and Executives connected with the Society. Some of these were probably mere space-fillers, but the large majority of them, given some definite task to accomplish, turned in at the end of their term a work that was a credit to themselves, and to those who had placed them there. The space-fillers will probably be space-fillers to the end of their days. It is said that our character is formed very early in life.

Thus, if it is of benefit that we should learn the value of working shoulder to shoulder for the common good, and, if it is of value that we learn to assume responsibilities, let us take the affairs of our Society with the seriousness that institutions which teach these things deserve.

As to the last charge it would seem scarcely worthy of answer. This is the thirty-fifth year of the Society. Thirty-four executives and thirty-two student Presidents have unselfishly given their time and energy to further the interests of the Society. Should we then look for more reward than they? Our reward is the knowledge that we have taken over the task from our predecessors, carried it on for the allotted run, and handed it over to those who follow, and our only hope is that those who come after will look back on this year's work and say, "Well done!" We care not that they recall names. If it be said that in the year 1920-21 the affairs of the Society were well run, that is sufficient, or, if some of our actions may reflect to the benefit of years to come, we care not whether they know the origin.

As for the more detailed work of the Society, it has been laid down in the Constitution that the routine work of the Society shall, as much as possible, be carried out by committees appointed from the membership at large. The object of this is twofold. First, it relieves the executive of a great deal of work and gives them more time for general supervision; secondly, it brings more men in the Society's activities, and brings these activities more vividly before the membership at large.

The Constitution of the Society has been printed, and will be distributed next fall to all its members. In ensuing years as each freshman registers, he will be handed a copy in order that he may inform himself of the Society's work.

To too many the objects of the Society are to run a Supply Department, a Dinner and a Dance. These are not the functions of the Society, but merely the most prominent evidences of its one object, viz., to be of service to its members, and it is only by being of service that it can thrive and maintain its place in the "School" life that it has always held.

The Supply Department must not be looked upon as a profit-making institution, but rather as a self-supporting department of the Society's activities, which by virtue of the slight percentage of profit it makes, shall have sufficient funds on hand to offer service that no competitor can. Its aim should be service. At the same time, it must be run on a thoroughly businesslike basis, and a sufficient reserve should be built up and maintained to provide for depreciation and losses in stock.

The Annual Dinner should be one of two get-together nights. The other, being election night, is rather too lively to replace it. This should be borne in mind by the committee, and the price and programme should be arranged accordingly. Facing a certain deficit in the dinner expenditure is merely another service that the Society can offer.

The Dance, although a later development in the activities of the Society, has assumed its place in University life. However, as its appeal is limited somewhat, the financial stand of the Society should be rather that of a guarantor, and the effort of the committee should be to put on the best function possible at cost.

I feel that these, as well as the other activities of the So-

CIVIL ENGINEERS' CLUB EXECUTIVE—1920-21.

Back Row—T. S. Glover, Varsity Representative; T. R. Emerson, 1st Year Representative; C. B. MacQueen, Secretary-Treasurer; W. J. Foley, 3rd Year Representative; M. C. Kelly, 2nd Year Representative, H. J. Elliott, 4th Year Representative.

Front Row:—Prof. C. R. Young, Hon. President; P. J. Culliton, President; E. W. Cockerline, Vice-President.

ciety, have been covered by those most intimately concerned, so lest I weary you by repetition, I will say no more.

The King is dead. Long live the King. The thirty-fifth executive of the Society has handed over the keys of office to their successors, and wishing them every success, congratulate you on your choice.

Personally, I thank the members of the executive who have worked so loyally this year, the Faculty Committee who have at all times been so willing to help us, and the members at large, for their continual support.

RALPH WALDO DOWNIE, President.

## ADDRESS OF RETIRING CHAIRMAN OF THE CIVIL CLUB

HAVING been asked to contribute something to the "Proceedings" as retiring Chairman of the Civil Club, it is not entirely to Civil Club matters that I will confine myself, but to some matters which should be of interest to all members of the Engineering Society.

With the readjustment of the affairs of the Society under the very able leadership of Mr. R. W. Downie, Committee Chairmen were struck, and it fell to me to conduct the annual dance and dinner for the Society. With regards to the dance, I have nothing to say beyond that it was a success, far surpassing my expectations. With the dinner—a different story is to be told. The dinner was not the success that I had hoped or anticipated. Less than 300 tickets were sold to under-graduate members of the Society. With an attendance of over 800 this is a very low percentage. What is the trouble? Where does the difficulty lie? In so far as I can see, the failure lies with the absence of sufficient school spirit, so manifest in years gone by. It was my privilege to represent the Society at the annual dinner of the Engineering Society of Queen's University this year, and among the things that impressed me was the fact that of a membership approximating 400 there were 300 of those members present for the dinner. Wherein then lies the difference? Are our numbers too unwieldy? I don't think so. Are we too much segregated so that all will not be reached alike? I don't think so. Is individual interest waning? I don't think so. Each one of us wishes to see the Science Faculty at the upper rung of the University ladder, and each one of us secretly hopes that it will stay there. Are there too many outside influences? No—not for the ordinary "School" man. By outside influences I mean those influences entirely separate from University affairs.

The social whirl within the University is too strenuous. In two ways is this so, one of which is the apparent fact that the pocketbook will not stand the strain, and ultimately collapses.

Could we not, within the School, reduce our socialities? Even this year we had quite a number of dances—I believe eight in number. Besides this, there was the dinner and Spasms. Is this too many? Some may not think so. This means an outlay of at last $60. The result of this is that something must be passed up. Dances do not create the same good feeling and fellowship so much desired among School men as the dinner does. If I might be permitted to make a suggestion, I would advance the idea of having four dances during the year. The School dance, the graduating dance, a Junior School dance put on by the first and second years and a Senior School dance put on by the third and fourth years. These, together with the dinner and Spasms, would be six functions in all. If this were followed out, I think that none would be failures. If this is not enough, let the School man attend some of the other Faculty functions. Besides this, there are the games, which calls forth derision if not well attended.

With all this we must not lose sight of the primary object of our presence at School—that of garnering sufficient technical knowledge, so that we might, upon graduation, be efficient engineers. In no Faculty in the University is the course more strenuous than Engineering. It demands the utmost ability of all of us, and if we do not devote a certain amount of time to this, we are losing part of what we come to School for.

In reviewing the activities of the Civil Club during the year, I feel that I did not devote the time that I should have to the matters directly concerning the Club. I had hoped to enlarge upon the activities so well started by Mr. E. C. Cowan two years ago and admirably continued by Mr. R. Harrison last year, but pressure of other School proceedings prevented this, and the work of the Club was left largely in other hands. In this connection my sincere thanks are extended to Professor C. R. Young, the Honorary Chairman of the Club, and to Mr. E. W. Cockerline, the Vice-Chairman, both of whom worked with undying enthusiasm to make the activities of the Club top-notchers.

In the early part of the year a smoker was held and voted a success. Mr. R. O. Wynne-Roberts, Chairman of the Toronto Branch of the E. I. C., and Professor C. R. Young both spoke briefly at this. Then meetings of the Club were arranged during the year, and some very prominent men in the Engineering profession addressed us. At our first meeting Dr. T. Kennard Thomson, one of the earlier graduates of the School, the founder of the Engineering Society, and the only man upon whom the University of Toronto has conferred the honorary degree of D.Sc., presented a paper on the Greater Niagara Development. Two subsequent meetings were held, addressed by Mr. W. P. Murray and Mr. Jas. Robertson, both engineers of prominence, connected with the Dominion Bridge Company. Another address was given by Col. H. C. Boyden, of the Portland Cement Association, on "Recent Developments in Concrete." At our last meeting a paper was presented by Mr. Wm. Gore, M.E.I.C., on "Reservoirs." These meetings, although tolerably well attended, did not draw sufficient numbers to warrant such work being expended in arranging them, and the last meeting was almost a disgrace. The average student does not place sufficient importance upon the experience of practicing engineers.

Trips were conducted to different places of interest in Toronto, and were well patronized.

A pre-war condition was re-instituted in the formation of the new Structural Club which commands particular commendation. Mr. G. D. Maxwell was elected Chairman of this Club, and the affairs of it were well conducted.

Part of the fees collected was for the purpose of conducting an employment bureau which was started by Mr. Cowan, but confliction arose between the Club and the Faculty, so that I had a motion put through, whereby the Engineering Society did this centrally, thus allowing a greater portion of time to be spent in arranging meetings, etc.

It is with considerable pleasure that I now introduce my successor, Mr. G. A. McClintock, to you.

P. J. CULLITON.

## THE MECHANICAL AND ELECTRICAL CLUB

THE request has been made that the writer, as Chairman of the "Mechanical and Electrical Club of the Engineering Society," review the activities of that organization during the year just drawing to a close. In complying with such a request it is the intention to offer such constructive criticism as will be of value to his successor in office.

During the past year six meetings of the Club have been held, including a smoker in Hart House, being an average of one per month, which is all that provision has been made for with respect to general meetings. All meetings, with one exception, were well attended, and all the addresses proved entertaining and instructive. The value of advertising such meetings as may be held cannot be stressed too greatly. The writer would advise inserting notices in the *Varsity* for at least three issues before the date of any meeting, and the conspicuous posting of large placards at least one week before the meeting. This done, one may rest assured that the audience will satisfy all expectations in point of numbers.

As to speakers for such meetings, it would seem advisable

MECHANICAL AND ELECTRICAL CLUB EXECUTIVE, 1920-21.

Top Row:—G. W. Smart, Curator; Prof. R. W. Angus, Prof. H. W. Price, Honorary Chairmen; A. W. F. McQueen, Treasurer.
Seated:—M. C. Stafford, Chairman; B. H. Johnston, Secretary.
Inset:—G. A. Brace, Vice-Chairman.

to consult members of the faculty in the matter. They are only too willing to offer excellent advice upon the choice of such men as they know. Care should be exercised to obtain gentlemen who are fluent in their speech and at the same time are able representatives of the particular branch of Mechanical or Electrical Engineering in which they may be engaged. It might also be here pointed out that too much technical harangue detracts a great deal from the value of an address, in the eyes of the average under-graduate, especially in the lower years.

The "annual dinner" for the past two years has been side-tracked, but this last year there was substituted a "smoker." To the writer's mind it appears that a "smoker" held once a year, or even twice during the year, is far more suitable than a "dinner." At the former everything is strictly informal, those present get a chance to mix together and become better acquainted, and, taken on the whole, such a function is more conducive to social intercourse. The "smoker," being by far the cheaper affair, attracts a great many more eager participants than would be so in the case of the more costly "dinner."

The Chairman of the Club will find, upon his succession to office, that as a member of the central executive of the Engineering Society, there devolve upon him many duties which he did not before realize would fall to his lot. It behooves him then to do his utmost to bring about the election of a strong Club executive, an executive upon which he will have the confidence to shift a great many duties, knowing that such duties will be faithfully looked after. In closing I wish to congratulate Mr. Duncan upon his election and to wish him the greatest possible success in his administration of the affairs of the Club.

M. C. STAFFORD.

## THE MINING AND METALLURGICAL CLUB

THE year 1920-21 has been a very successful one for "The Mining and Metallurgical Club." The primary object of this Club has been to enable the students to keep in close contact with the "Field," even though they may be pursuing their studies in a place hundreds of miles away from the mining camps. One way of doing this is by having prominent teachers in the mining and metallurgical world come and address the students at informal "smokers" and meetings. The Club was remarkably fortunate this year in being able to secure as speakers, men very high up in their various professions. Another good point concerning these meetings was that a very inspiring feeling of good fellowship was created among the members as they met on a common ground, and had a hearty, jolly time together. The popularity of these was further shown by the incredibly large attendances at all of them.

MINING AND METALLURGICAL CLUB EXECUTIVE, 1920-21.

Top Row:—C. M. Beck, Vice-President; R. J. Henry, Secretary; F. J. Lyle, 2nd Year Representative; J. Beattie, 1st Year Representative.

Bottom Row:—Prof. G. A. Guess, Hon. President; A. E. O'Brien, President.

The first "smoker" was held at Hart House in November with a record turnouut. "Coal" was the subject of the evening, and Mr. James McEvoy, a very prominent Mining Engineer and Geologist, gave a splendid address on "The Utilization of Western Coals in Ontario." Mr. McEvoy is a well-known authority on this subject, and his lecture was most instructive and interesting.

In December another "Coal" evening was held, at which a large number of the wholesale and retail men were present. Though the courtesy of the Sullivan Machinery Company, a three-reel moving-picture on "The Story of Coal" was shown. Before the picture was given, Professor Alexander Maclean, of the Geology Department, who has done a great deal of work in the Western coal fields, gave a very enlightening and interesting lecture on "The Origin of Coal." The moving-picture then took the audience to Pennsylvania, deep down in a coal mine and through every operation from the mining to the shipping. Finally, Mr. H. A. Harrington, Fuel Controller of Ontario, closed the evening with a very witty and timely talk on the troubles encountered by a Fuel Controller in the distribution of coal.

In January, a very successful "smoker" was held, and Mr. George Allan, Advertising Manager and Educational Director of the Consumers' Gas Company, delivered a wonderful illustrated lecture on 'Gas." This is published in another part of this book, and so needs no further mention except that Mr. Allan cast a great light on this most obscure subject.

The activities of the Club were brought to a close by an open meeting, on March 2nd, at which the whole "School" was present. Colonel Arthur L. Dwight, of New York, President of the Dwight-Lloyd Metallurgical Company, and one of the most famous metallurgists on the continent, gave an address on "Ore Roasting and Sintering." Col. Dwight is the inventor of the Dwight-Lloyd Sintering Machine, and so dealt with his subject as no other man could. This address is also published in this book.

ADRIAN E. O'BRIEN.

## THE ARCHITECTURAL CLUB

THE ARCHITECTURAL CLUB of the Faculty of Applied Science and Engineering, although not known to many members of School, is a most active organization, and a most successful year has been brought to a close under the able leadership of the Executive, of which the members are: Hon. President, Mr. H. A. Moore, President Ontario Association of Architects; President, T. J. Young '21; Vice-President, E. W. Haldenby '21; Treasurer, M. A. Norcross '22; Secretary, A. S. Crawford '23; Councillors, J. B. Helme '22, J. G. Magee '23, A. R. Smythe '24,

The opening meeting of the Club was held at the Mulberry

INDUSTRIAL CHEMICAL CLUB EXECUTIVE, 1920-21.

Standing:—H. B. Meyer, 3rd Year Rep.; H. N. Baker, 1st Year Rep.; E. M. Begg, 2nd Year Rep.; C. P. Lailey, 4th Year Rep.

Sitting:—H. Kesteven-Balshaw, Sec.-Treasurer; Prof. J. W. Bain, Hon. President; A. D. R. Fraser, President; Prof. E. G. R. Ardagh, Hon. Vice-President; C. J. W. McKeown, Vice-President.

Tea Rooms, on which occasion Dean Mitchell introduced to the Club the new Professor in Design, Mr. Adrian Berrington, late of the University of Liverpool. Prof. Berrington gave a very interesting talk on "The Classic Style of Architecture."

Later in the season Mr. H. A. Moore, the Honorary President, gave a very interesting address on "The Modern Methods of Architecture," in which he dealt principally on the difficulties encountered by students after graduation.

The senior members of the Club also enjoyed several tours of inspection, among which were, the inspection of "Pantage's," through the courtesy of Mr. Baldwin, of the Department of Architecture; the visit to the plant of the Standard Sanitary Co., Limited, under the leadership of Mr. H. H. Madill; and the trip to the factory of the Dunham Co., Limited, which was arranged by Professor C. H. C. Wright.

The entire Club, however, had the pleasure of inspecting the King Edward Hotel extension, and nearly all have selected their rooms for future occupation.

The grand finale, however, occurred on March 11th, when the annual elections were held, and the following officers elected: President, J. B. Helme '22; Vice-President, M. A. Norcross '22; Treasurer, J. G. Magee '23; Secretary, P. A. Deacon '24; Councillors, F. B. Brown '23, E. M. Coleman '24.

The election of an Honorary President and Freshmen's representative were left over till next fall.

## THE INDUSTRIAL CHEMICAL CLUB

THE INDUSTRIAL CHEMICAL CLUB was founded in the session of 1908-1909 as an independent Club to further the professional and social interests of the men in the Chemical Department. Prominent among those who fathered it were Mr. MacKenzie Williams '09, of the the financial firm of A. E. Ames & Company; W. H. Thom '10, of Lyman Bros.; A. R. Duff '09; A. E. Gooderham '09; A. V. DeLaporte '10, Chemist in charge of the Experimental Plant of the Provincial Board of Health; E. R. Williams '11, and Mr. A. R. Bonham '14, Chemist of the Province of Ontario.

Through the ensuing years the Club was firmly established by the earnest work of its successive Executive Committees, providing a means of developing public speaking among its members, and organizing the Chemical students into a definite body.

In 1914 the Club was incorporated with the Engineering Society, as one of its sections. By a recent revision of the Society's constitution, the Club, in common with the other sections of the Society, was drawn closer to the central organization. This revision of the constitution provides for financial grants being voted to the sections in case of necessity; and for safe-keeping of their books, properties, etc., by the Curator of the Society during the Summer Vacation.

During the past Session, 1920-21, the Club abandoned its monthly dinners of former years, and substituted for them monthly smokers in Hart House, held more or less regularly. It was felt that a substantial attendance could not be expected at dinners, considering all circumstances. It is to be hoped that conditions in the future will permit of a return to the old order, for unquestionably a dinner is more pleasant than a smoker. Indeed, it is expected that the Executive of 1921-22 will restore "the ample board."

The session of 1920-21 commenced with the following Executive in office: Honorary President, Professor J. W. Bain; Honorary Vice-President, Professor E. G. R. Ardagh; Chairman, A. D. R. Fraser '21; Vice-Chairman, C. E. J. McKeown '22; Sec.-Treas., H. Kesteven-Balshaw '23; Curator, R. A. Gordon '24; Year Representatives, C. P. Lailey '21, H. B. Meyer '22, E. M. Begg '23, H. N. Baker '24.

During the year a number of very interesting addresses were presented to the Club.

Mr. W. H. Thom '10 delivered a paper on the "Treatment of Raw Drugs." Mr. Thom described the various drugs of vegetable origin which are commonly used in pharmacy, naming their sources and the processes to which they are subjected in refining. A practical demonstration of the general method of extraction added a pleasing feature to the address.

Mr. G. Norwood Comley, Manager of the Canadian Brunner Mond Co., of Amherstburg, Ontario, spoke on the "Soda Industry," paying particular attention to the plant operation of the Solvay Process. Present on the occasion was Sir Edmund Walker, President of the Brunner Mond Co. Sir Edmund, in a short address, recalled the early days of the Western Peninsula of Ontario, and showed how its promise had been fulfilled by the establishment of the soda industry in the centre of the salt district.

Mr. C. Price Green, Commissioner of Resources of the Canadian National Railways, addressed the Club on "The Natural Resources of Canada." Slides were shown of centres and individual mills from the Atlantic to the Pacific. Mr. Price Green dwelt at length on the pulpwood resources of the Dominion.

Harold J. Roast, of Montreal, Secretary of the Canadian Institute of Chemistry, presented a very valuable paper full of sound advice to the young Engineers. It is reproduced at length in the "Transactions of the Engineering Society."

Mr. Sowers, of Buffalo, New York, exhibited a collection of slides of the famous "Dopp" Jacketed Kettle. Pictures were shown of apparatus made specially to order for certain firms, designed to overcome the difficulties in the process of manufacture. Many ingenious devices were described. Mr. Sowers, on leaving the City of Buffalo, presented two laboratory-size jacketed kettles to the Department of Chemistry.

The Club undertook a personal canvass of the chemical industries in the Western and Central parts of the Province during the Christmas vacation, in an effort to secure summer employment for its members. No immediate success was attained, nor has subsequent correspondence resulted in the placing of any men. In the words of most of the replies to our letters, "we regret that the unsettled state of the industrial field makes it impossible for us to offer you any openings." The campaign, however, regarded as missionary work, was very promising.

The Club's year closed with the final meeting, in the form of a dinner, in Hart House on Wednesday, March 16th. Professor J. W. Bain, Dr. M. C. Boswell, Professor E. G. R. Ardagh, and Professor Adams represented the Staff. Mr. L. E. Westman, Managing Editor of *Canadian Chemistry and Metallurgy*, was also present. After brief speeches from the Staff and from Mr. Westman, the newly-elected Chairman for the coming year, A. E. H. Fair '22, took charge of and adjourned the meeting.

The Executive, on behalf of the Club as a whole, wish to thank the speakers who contributed so largely to the year's success. Their thanks are also due the Staff for the interest which they took in the Club's plans.

## SCHOOL HISTORY

The School has a history, not the kind that appears in the calendar, or that which used to be popular with textbook writers (never with pupils), but a real history, a story of people and the events that went to fill up the year and build a tradition around the "Old Red School." If you doubt it spend a few hours with some old grads, and you will cease to wonder at the large gatherings at the Alumni reunions.

Should not some effort be made to collect and publish either in these pages or separately, the story of the Old School? The Executive this year hoped to do something, but were unable to find time. Let us hope that there will be sufficient interest shown to bring this matter before their successors.

## THE DEPUTY FIRE MARSHAL'S PRIZE ESSAYS ON FIRE PREVENTION

To bring the work of the Ontario Fire Prevention League more closely before the Engineering Students, and to promote

FACULTY OF APPLIED SCIENCE AND ENGINEERING, FOURTH YEAR EXECUTIVE.

Top Row:—H. J. Elliott, Civil Rep.; C. C. Wimperley, Varsity Rep.; G. Dean Maxwell, Secretary-Treasurer; inset, C. P. Lailey, Chemical Rep.; T. J. Young, Architect. Rep.; G. A. Brace, Elec. and Mech. Rep.; A. E. O'Brien, Mining Rep.

Bottom Row:—J. Roy McLean, President; T. R. Loudon, B.A.Sc., Honorary President; J. Roy Gilley, Vice-President.

an active interest therein, Mr. Lewis, the Deputy Fire Marshal of Ontario, has donated a group of prizes for essays on the subject of "Fire Prevention." The contestants were divided in four groups, as follows: Group I., Civils and Architects; Group II., Miners; Group III., Electricals and Mechanicals; Group IV., Chemists. The prize for each group is textbooks to the value of $15, of the student's own choosing. Owing to the fact that it was not until late in the year that news of this offer was received, the response was not as great as it should have been. Essays were received from Groups I. and II. only, and the essays of the winners, W. L. Clairmont, 2T2, Civils, and A. L. Irwin, 2T1, Metallurgists, are published herein. It is to be hoped that Mr. Lewis may see fit to continue this competition next year, and that its announcement in the fall term will meet with a hearty response.

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## 2T1

PERHAPS the present graduating year is more unique than any that has ever gone out of the "School" heretofore. So far as the different entrance years are concerned, we are without a doubt the most cosmopolitan crowd ever graduating. We have men with us from almost every year since 1T3. However, on the whole, the members of this diversified year have supported admirably well, everything undertaken.

Concerning the activities, very little need be added to that which the majority of us already know. Early in the fall a very enjoyable smoker was held and voted a decided success, in that the boys were all glad to be back renewing old acquaintances and forming new ones.

Later in the term an informal dance was held at the Metropolitan Assembly Rooms, where the members were again given the opportunity of enjoying themselves as only "School" men can.

During the term the "Structural Club" was again brought back to life after a dormant period of several years. Mr. G. D. Maxwell was elected Chairman of this organization and deserves credit for the work carried on. Among other places visited by this club was the new King Edward extension, where Mr. Hagarty, a "School" grad, and the Structural Engineer in charge, kindly explained things of interest. Professor C. R. Young, the Honorary Chairman, accompanied the club on this trip, and also directed the attention of the members to interesting and modern Structural Engineering.

During the first term a trip was also taken to Niagara Falls, Ont., when a tour was taken over the construction of the Hydro

Chippawa Power Development. Our thanks are tendered to Professor Angus, who was in charge of the tour, and also to the Engineering Staff of the Hydro Construction, who did everything possible to make our visit to the work an enjoyable one.

The crowning event of the year, however, took place on January 11th, when the Graduating Dance was held in Jenkins' Art Galleries. The following kindly consented to act as patronesses, Mrs. C. H. Mitchell, Mrs. C. H. C. Wright, Mrs. H. E. T. Haultain, and Mrs. T. R. Loudon. A novelty dance was conducted during the evening, and the prize was tendered to the winner by Brig.-General C. H. Mitchell, our Dean.

My sincere thanks are extended to Mr. J. R. Gilley, Vice-President, and Mr. G. D. Maxwell, Sec.-Treasurer, of the year, for their co-operation and hard work in order that the activities of the year might not lag.

J. R. McLEAN, President.

## 2T2

THE past year for the class of 2T2, has been a most successful one. Quality, rather than quantity, has been their motto with regard to class functions. In fact, this was almost a necessity, in view of the many affairs, social and otherwise, which have found a place in our University life.

Two smokers were held, one during the Fall term, and one during the Spring term. The first was most successful, from the point of view of attendance, while both were successful, from the point of view of those who attended. Cards, smokes, eats, and an excellent programme by three or four of the year's distinguished musicians, comprised the evening's entertainment, in each case.

Another most important event of a similar nature must not be forgotten here, namely, the Gull Lake smoker. The first part of the evening was taken up by a very exciting game of indoor baseball between those deadly rivals, the Civils, and the Miners. This was followed by a very generous feed, and short speeches by two or three members of the Staff.

The Year dance, which was held at the Metropolitan Assembly Rooms, was one to be remembered. While, of course, not to be compared with the "School" dance, it was, nevertheless, one of the finest class dances at Varsity this year. If you don't believe it, ask anyone who was there.

The only official trip taken by the year was that to Buffalo, to inspect the Lackawanna Steel plant. Unfortunately, it came at a time when the finances of most were at low ebb. However, the thirty or forty, who were able to go, derived considerable benefit therefrom, in addition to the fun of the trip. The arrangements were made by Professor Loudon, and much thanks is due him for his work and interest in the whole thing.

This review would not be complete without some mention of our individual successes in various activities. To begin with, the two best skits in "Spasms" were put on by men of 2T2, one by the Chemicals, and the other by the year as a whole. Then in athletics, and other activities we have had several shining lights. Beattie Ramsay, the Captain of the Hockey Team, and of whom we are all justly proud, is a member of 2T2, as is likewise "Spike" Carruthers, the Captain of the Track Team, and one of the best athletes in Canada. Besides these two, many others have brought glory to themselves, and to "School," in all the various branches of athletics. And this article would still be incomplete, without some mention of the Editor of *Varsity*, "Fat" Gardner; the Leader of the Toike Oikestra, "Scottie" Hamilton, and the Billiard Champion of the University, "Happy" Philp.

"2T2" may therefore be justly proud of its activities during the past year. Not only have the class festivities been all that could be desired by the most exacting person, but, in the broader lines of University activities, 2T2 has come well to the front. It has demonstrated what a solid, united class spirit among all the members of the year will do towards the success of any undertaking.

H. G. THOMPSON.

## 2T3

ELECTION time is the only occasion outsiders compliment our class. At that time we learn from some of the candidates in a very profuse mixture of sophistry and blarney just how great and fine a crowd we are. Confidently, dear reader, they say we are a powerful body in the Faculty of Applied Science. But election day is past, and some of us who were so sophisticated as to believe the candidates are forced now to tell the plain truth about ourselves. You know what H. H. Lawson said about that. In October, 1920, we started out 402 strong—over fifty per cent. returned men—, but through the untiring work of "Tony" Reid and his executive, within six months this mob was transformed into a harmoniously working body who had accomplished big things. The old soldiers' "Prep Class" was the backbone of the organization. Then our first misfortune befell us. The events which were carried out in the early part of April were the cause of a considerable number of our pals being taken from us, many of whom were the bright men of the year, but whose patriotism and interest in class activities cost them dearly. Even if not in engineering achievements, many of these men will be famous in other lines.

However, those who are simply taking their course in five years instead of four are and always will be 2T3.

In October, 1921, 320 of us started out on the second lap, no sadder, but a wiser lot. There is no need here to deliberate on the depths into which we have been led, and which we explored—more or less—because these are known to all School men except the Frosh, and here we say, "Poor Frosh." In the labs and draughting room Sherman is often quoted, with the local work substituted for war, but we wish to quote the gentleman who wrote "Ignorance is bliss." In this regard we would refer again to the wisdom acquired last year. Last year, at frequent intervals, a large contingent of 2T3 would give the Profs a holiday and help Mr. Solman's Building Fund by attending one of his sessions. He didn't seem to appreciate it as much, though, as do the Arts girls when you assist the W.B.F. by renting a portion of J. and J. J. Allen's moviedrome for an evening, and ofttimes, it seems, from reports of the faculty office, our presence caused him uneasiness. This year, however, our excursions led us not to King or to Richmond St., but to Baldwin's Steel Plant, the Consumers' Gas Co., and the Hydro Laboratories.

In social functions we had a good year. Our big night was when we introduced the Frosh to School customs. It was a ripsnorter. The Dean said it was a great initiation, but, thanks to the wily custodian of the Goat, he didn't see all. The Frosh returned the treat by a fine theatre party down town. Some of the boys remember it; some don't.

We had two good dances which were well patronized and enjoyed and were a credit to the Dance Committee.

The year is well represented in all the Faculty, University and Hart House organizations. There are a great many who attend the E. I. C. meetings and are student members. The E.I.C. Convention meeting and smoker found many 2T3 men present.

Much credit of the success of SPaSms is due to C. T. Carson, stage director; D. MacBeth, stage manager, and O. D. Johnston, business manager.

All executive positions were keenly fought for in the elections, and good men were elected, Bert Morris and Jack Coulter both being raised from the year Executive to the Society Executive. "Spud" Murphy will fight our battles in the Council.

In athletics we certainly contribute our share to the University and Faculty teams. A brief survey of the University teams shows one or more representatives on each one. First Rugby Team—Duncan, Earle, Rolph, Carew and Sullivan (1st year, but still 2T3). Hockey—First team, Sullivan; second, McCullough and Thomson; 3rd, Greey. Basketball—Duffill. Boxing—Relyea, Seaborne and Goldie. Track—Meredith. Swimming—Wells, Lindsay, Harston, Fitzgerald. Water Polo—The four swimmers, Schinbein and Bell. Tennis—Williams. Rowing—Bell and Smith. Soccer—Evans and Johnston.

This makes a dozen "T"holders and a great many "S"holders. Next year Senior School wants the Mulock, Sifton and Jennings Cups.

Pat Lyle surely started something when he instigated intergroup competition. Here are some results: Chemicals beat the Miners by 38-8 in a close game of basketball—that is the men were close to each other. However, the Miners came back at the Chemicals by 2-1 in a game of hockey, but the Civils worked off a few pounds when they led the Miners home in a 15-man relay race. The water polo game didn't come off.

Of course, there is no use trying to get into School a week early next fall, but in conclusion there is 90 "bucks" in the treasury, and John Farley is our new President.

A. A. BELL.

## 2T4

AT the beginning of each academic year, just when the leaves are beginning to put on their autumn colors, a new class is formed; new acquaintances are made, new friends meet, and new experiences are felt. This has been true of 2T4; and as each member of the new year found his way to the "little old Red Schoolhouse" new and individual sentiments made themselves known, for was not this the beginning of life's work—but enough of sentiment!

After days of seeming whirl and confusion, the routine was discovered—quite accidentally by some. All had learned to think of themselves as "University" men. The all-important elections were held, and fortunately, or through excellent judgment, a splendid executive was chosen. This meant a good beginning for a good year, as late events have shown.

But this was not all in those "early days." The Dean took advantage of the first opportunity to address and welcome this class of 2T4. His remarks were full of anxious warning against too much frivolous social activity, and to the younger he pointed to the fact that they were to a greater extent their own masters now, and should live accordingly. It is quite certain that this timely warning was not without its good results.

Here, now, cometh a very much remembered event, warmly so, indeed. That event was the initiation. For some weeks many were the hazarded guesses and many were the suspicions concerning this woe of the Freshmen. At last the evening came, and, in clothes suggestive of the ash-cans and garbage heaps, the Frosh lined up in "alphabetically order," and, one by one, went through those awful degrees at a spanking good pace to a final demonstration of the mysteries of "School," on the top floor. The clause of secrecy does not permit a full description; so let us pass on to the next event of the year, which was the "smoker," and of particular interest, because the terrible offenders who had deserted their comrades in the face of the initiation, were to be justly punished. After a close investigation and trial the offenders were found guilty and sentenced to the same treatment as had been meted out to their fellows. In the presence of all and sundry the sentence was duly executed. Again secrecy binds us, and we will say no more.

Improving steadily and growing wiser every day, the year felt that the time had come for "a little dance." So, keeping in line with this improvement, the executive secured a most luxurious place, and after much trouble and preparation, the night of nights came, when, with fair ladies, the embryo engineers danced the night away. A dance, at best, is difficult to describe, and as this is not the society column, the description of the gowns will be omitted, and also the "among those present," but, suffice it to say, that there was not one jarring note in the whole evening,—except, perhaps, the bursting of one or two balloons—and that it was with great regret the dancers left for home—and lectures next morning—longing for another "night." This next night came in due course, and served as a safety-valve for much energy gathered in the weeks after the Christmas vacation. The evening was spent at a theatre, and, contrary to the years of many, the "riotous" Freshmen only served to relieve the monotony between acts—much to the joy of the manager. Several representatives of a rival college hockey team happened to be there, and after they had made known their presence, a song of regret and sorrow, sung to an old familiar tune, was rendered for their benefit. This social number was another signal success.

Not in sport alone is 2T4 science engaged, but in almost every School and Varsity activity, from the Glee Club to the Debating Club. Right here, it would be well to mention the part taken in the School Debating Club. Early in the year keen interest was shown by several of the class in this important club. After defeating the Second Year in a lively debate, the finals were entered with the Third Year as opponents. Here again the year scored by winning the shield for debating.

In concluding pardon is asked for any undue conceit, but let us say that no Frosh year has a better outlook or a more friendly feeling, or a better chance to uphold the traditions and reputation of this old Varsity and School.

OSBOURNE.

# Engineering Society

## ELECTION RESULTS

### Engineering Society Executive

*President*.........................................Jack Langford
*Vice-President*..................................H. M. Morris
*Treasurer*........................................H. J. Coulter
*Corresponding Secretary*....................G. M. Crossgrove
*Curator*............................................J. W. Reid

### Chairmen of Clubs

*Civil Club*...................................G. A. McClintock
*Mining and Metallurgical*....................J. Drybrough
*Chemical Club*..................................A. E. H. Fair
*Architectural Club*...........................W. B. Helme
*Electrical and Mechanical Club* (acclamation)..W. C. Duncan
*Debating Club* (acclamation)..............D. W. Rosebrugh

### Athletic Association Executive

*President*..............................W. Beattie Ramsay
*Vice-President*................................M. P. MacLeod
*Secretary-Treasurer*.........................Robert Relyea

### Year Presidents

*Fourth Year President*.........................S. Coulter
*Third Year President*............................J. Farley
*Second Year President*.......................J. M. Dymond

### Year Athletic Representatives

*Fourth Year*........................................K. Greig
*Third Year*...................................F. S. Seaborne
*Second Year*.................................K. V. Heyland

### Students' Administrative Council Representatives

*Fourth Year* (acclamation)..................H. G. Thompson
*Third Year*......................................F. A. Murphy
*Second Year* (acclamation)..................W. A. Osborne

### Permanent Executive of Graduating Year

*President* (acclamation)........................J. F. Young
*Vice-President*....................................J. M. Breen
*Secretary-Treasurer* (acclamation).............E. J. Marsh

### "School" Y.M.C.A. Executive

*President*.........................................T. S. Glover
*Vice-President*..............................J. W. MacIntosh
*Secretary-Treasurer*..........................L. C. Jackson

S.P.S. DEBATING CLUB EXECUTIVE, 1920-21.

Left to right:—A. S. F. Murphy, 2nd Year; G. P. Sabiston, 1st Year; J. D. Relyea, 4th Year; D. Goldstick, I.C.D.U. Debater.
D. W. Rosebrugh, Secretary-Treasurer; G. A. Brace, President.

# S. P. S. DEBATING CLUB

THE S.P.S. DEBATING CLUB has come into its own as one of the leading clubs in School, and a member of the Federated Clubs in the Engineering Society. A membership of over one hundred has proved that whatever engineers have been in the past, they are not now indifferent to the value of public speaking.

The first meeting for the session 1920-21 was held on October 22nd in Hart House, when the election of all the officers but the President took place. This meeting was a get-together one, and each man was given three minutes to speak upon his work during the past summer. Arrangements were made at this meeting for the executive to choose the debaters for the debate against University College, which was to take place in November.

On November 10th a meeting was held to discuss the subject for debate with U. C., which was "Resolved that the principle of self-determination is a false basis for the settlement of boundaries." This proved to be rather an abstruse and uninteresting subject, and we were defeated on November 16th by U. C., which had the affirmative.

On December 14th a meeting was held as a preparation of a limited company. Hon. Mr. Justice Masten, the President of the University Alumni, kindly explained the salient points, and plans were immediately put under way for the floating of the company. At this meeting also Mr. W. E. Bennett, the Curator of the Engineering Society, was appointed our representative on the Engineering Society Executive, with power to award the Engineering Society Cup for the best speaker in "School," and the Segsworth Debating Shield to the successful year in the inter-year debates.

On January 18th the first of the inter-year debates was held, between the First and Second Years, upon the subject, "Resolved that it will be better for humanity if it concentrates its energies upon social reforms rather than scientific progress for the next eighty years." The First Year, who had the negative, were judged to have won.

On January 28th the second of the inter-year debates was held, between the Third and the Fourth Years. The subject was "Resolved that male and female bachelors ought to be taxed more heavily than they are, in order that married men under thirty may be totally exempt." The Seniors upheld the motion, while the Juniors held the reverse view. This debate was very funny, and was judged with great impartiality by a bachelor and a married man. The Third Year won.

On February 8th the largest and most successful meeting of the year was held, when a limited company was formed, known as the "Dynaloids Products' Limited." Extensive advertising produced a crowd which filled East Common Room, Hart House, to overflowing. Mr. Laidlaw, a School grad. of 1915, and now a lawyer, carried the company through the usual routine meetings in the initial stages of the company's life. The rest of the meeting was planned and carried through solely by members of the Club.

At a Directors' meeting, held about six months after the formation of the company, the by-laws were read, and a special meeting of the shareholders was called as a result of the demands of shareholders holding one-tenth of the subscribed stock.

This meeting was held directly and proved to be a series of startling and disastrous developments for the company. The invention was ridiculed by a prominent engineer, then supported by the supposed inventor, who upheld the soundness of his product. The unexpected appearance of the real inventor, Mr. Borden, of the H. E. P. C., who accused the company engineer of pilfering his invention, threw discredit upon the whole company. An adverse balance in the company's books decided the stockholders to go into an assignment, and an assignee was appointed.

At the assignee's meeting, creditors and employees pressed their claims, and the assignee explained their legal rights. As the assets were not enough to pay the wages, the directors were held responsible for these. One of the leading promoters, while within the law was shown to have used sharp practice in floating a doubtful invention. The shareholders were held responsible for the remainder of the subscription on their preferred stock, and for the full value of the bonus stock.

The talent for public speaking brought out at this meeting was surprising, especially among the First year, and the continued humorous sallies kept the audience in roars of laughter.

For the purposes of promoting interest in the Club, and of actual training for individuals in speaking before a large audience, the evening was a great success. School men usually associate debating or speaking with a dry evening, but this venture proved that such is not at all the case. More of such meetings could be held with profit in the future, but earlier in the year, when the advertising would be of greater value to the Club itself.

The success of the evening was solely due to the co-operation of the members in putting their best into it, and especially of a few members who spent an immense amount of work in planning. The prospectus, printed by the International Nickel Co. of Canada, at great expense and trouble to themselves, proved to be the leading factor in advertising the meeting. The aid so kindly extended by Mr. Laidlaw was invaluable.

At a general meeting of the Engineering Society on February 23rd, a motion of affiliation of the Debating Club with the Engineering Society was passed. This ensures us representation on the Engineering Society in future.

The last, and certainly one of the best meetings of the year was held on February 28th, in the East Common Room, Hart House. The meeting was a double one. The first part was the final inter-year debate between the First Year and the Third. The subject was, "Resolved that the group system of Government is better than the two-party system." The old adage that "History repeats itself" was proved to be false at this meeting, for although the Third Year were successful against the First in the spring of 1920, yet this time the Frosh won, and rightly so, not only on account of the amount of work they had done for the debate in question, but in view of the interest they have taken all year in the Club. To them then belongs the Segsworth Shield for the year.

The Oratorical contest for the Engineering Society Cup was the second part of this meeting. Professor Greaves, of Victoria, judged between the sixteen competitors, and gave many valuable hints to them upon the correction of their style. He awarded the cup to Mr. Brace '21 and Mr. Rosebrugh '22, who had tied After mutual felicitations the Club disbanded for the year.

At the annual School elections Mr. Rosebrugh was elected President by acclamation in recognition of his outstanding ability and unsurpassed services to the Club during the year. I feel that the Club could not be left in better hands.

G. A. BRACE, President.

## FACULTY OF APPLIED SCIENCE Y.M.C.A.

THE Y. M. C. A. of the Faculty of Applied Science was organized in 1905, and it forms an integral part of the University Y.M.C.A., which is a Federation of the Association in the various colleges and faculties. During the past year the Association has become affiliated with the Student Christian Movement of Canada, a movement embracing all students, men and women, throughout the Dominion, which is attempting to form a closer bond of federation between the various Christian organizations in the Canadian Universities and to promote Christian work in them.

Membership in the Y.M.C.A. is open to all students in the Faculty, and the Association seeks, through study, prayer and other means, an understanding of Jesus, and invites into its fellowship all students who are willing to test the validity of the conviction upon which the association is founded.

The work during the past year has been carried on under the leadership of F. W. Dunton, President of the Association in the Faculty of Applied Science. Classes were organized to study the life and teachings of Jesus under the leadership of Professor C. H. C. Wright, Prof. J. Roy Cockburn and Dr. Sharman, as

S.P.S.—S.C.A. EXECUTIVE, 1920-21.
F. A. Murphy, J. H. McIntosh; T. S. Glover, C. J. McKeown.
F. S. Spence, F. W. Dunton, Prof. Wright, W. O. Longworthy, A. A. Bell.

well as several groups led by students. These groups have been of great interest and help to the students throughout the year.

A group of those who were interested in Boys' Work and Community Service was organized, and met once a week throughout the year. Prominent men in boys' work addressed the class on problems relating to the 'teen age boy, and an opportunity was given to the members of the group to lead a class of boys during the week.

The Y.M.C.A. has been active not only along lines of study, but in extending a welcome to the first year men. Hand-books containing useful information for the students have been distributed, a rooming list has been kept, as well as a book exchange. At the beginning of the year a reception was held in Hart House for the first year men, at which the aims of the Association were presented to those present.

On the whole, it may be said that the year has been successful, but those who are interested in the aims of the Association are looking forward to a time when all the students will take an active part in the Christian activities of the University.

## THE ANNUAL AT-HOME

THE ANNUAL AT-HOME was held on the evening of January the third in Hart House. The marvellous combination of the big gym, the Great Hall, the pool with its soft lighting for sitting out, and the Common rooms as auxiliary dancing floors, could be found in no other building. The lights and decorations were so admirably designed as to put to shame some faculties with more claims to artistic abilities; the much-needed rendezvous of the various clubs were exceedingly novel, while the "Psalm of Life," stretched along the walls, emulated Milton's Areopagatica in the Great Hall. The orchestra, under the direction of Mr. J. Wilson Jardine, entered into the spirit of the evening and provided an excellent programme of the best popular music.

The supper was divided into two sittings, which eliminated much waiting and all confusion. During a supper extra, balloons which had been suspended under the roof, in a huge Union Jack, were released. The scene as they fell, all sizes, colors and shapes, while the spotlights played upon them and upon the dancers beneath, was one of great gorgeousness and beauty. Shortly afterward photos of some of the Faculty's brightest stars were shot upon the screen. These included President Downie, Joe Breen, Gordon Duncan, "Spike" Carruthers and Beattie Ramsey. *Nunc plaudite!*

Eclat was lent the evening by the presence of many members of the E. I. C., who were in town for the Annual Convention, and had been presented with complimentary tickets by the

SCIENCE DANCE COMMITTEE, 1920-21.
Standing:—G. W. Smart, F. W. Dunton, C. B. Macqueen, G. Lindsay, F. S. Spence.
Sitting:—G. V. Rayner, Vice-Chairman; P. J. Culliton, Chairman; R. W. Downie.

Toronto Branch of the E. I. C. Among them were many of the school's younger graduates, and also some of Canada's foremost engineers,—many of them graduates of "School."

Everyone enjoyed the dancing to the utmost, the numbers being well chosen and the lighting effects rich and well balanced. The numerous encores given were sufficient indication of the appreciation of the dancers.

Though the dance was one of unusual size, yet it had the inimitable touch, that air of *bon homie* which always prevails at "School" functions. It was undoubtedly one of the best "At-homes" in many years, and it will linger long as a fragrant memory in the minds of those who were fortunate enough to be there.

## THE SCHOOL DINNER

IN each School year, there stand out three major events—the Engineering Society elections, the School Dance and the School Dinner. Of the two social functions, the dinner is probably of greater importance, since it is attended by a larger portion of the student body.

This year witnessed a new departure in the holding of the dinner before, and not after, Christmas, thus removing an important function from an overcrowded term. Also it becomes a greater factor in the early awakening of a freshman's enthusiasm in his faculty.

In planning the Thirty-first Annual Banquet, the Dinner Committee made other changes which added to the success of the evening. The dinner was held in Hart House, the most appropriate place for it. The magnificence of the Great Hall emphasized the importance of the occasion, and its atmosphere fostered an air of closer association with the University as our Alma Mater and not merely as a place to gain a little knowledge of engineering.

Another innovation was the holding of a smoker after the actual meal. The diners moved from the Great Hall to the gymnasium, where the toasts were given. Here also, a short entertainment was offered by a number of the students. This feature engendered a closer and more friendly relationship between student and professor. This feeling is much strengthened by amusements of common interest, a feat which only one address in many could ever accomplish.

The students were practically unanimous in their approval of the excellent work done by the Dinner Committee, and general opinion placed the standard of this dinner above those of previous years. May this improvement continue and each dinner be bigger and better than the one preceding, and do its bit, as the others have done, in animating the spirit of Toike Oike.

SCIENCE DINNER COMMITTEE.

Back Row:—D. MacBeth, A. R. Smythe, S. L. Coulter, J. M. Dymond, A. E. O'Brien, L. F. Stokes.
Front Row:—E. A. Dunn, Secretary; R. W. Downie, P. J. Culliton, Chairman; J. W. Gardner, Vice-Chairman; G. D. Maxwell.
Absent:—H. A. Knight.

## RULES FOR FRESHMEN

THE now almost old-time bugbear, the war, has wrought many changes in the old-time traditions of School. Perhaps the most outstanding transformation is the abolition of the ancient free-for-all *melee* between the verbose Sophomores and the verdant Frosh, in favor of our now famous inside initiation.

The old-timers back at School last year looked upon the inauguration of the inside initiation with a great deal of misgiving. They prophesied the decay of the justly famous School spirit. But to the general amazement of all concerned, in the last two years it has laid the foundation of an *esprit de corps* in the first and second years that is equal to, if not greater than, that which existed in the balmy days before the war.

With the return to a normal Freshmen year, next fall, it was felt this year that some extra disciplinary measures were necessary for the benefit and uplift of the young and tender Frosh. A committee to draw up "Rules for Freshmen" was appointed by the President of the Engineering Society, and the following rules were drafted and passed at a general meeting of the Society:

The first group of rules will be enforced during the school year.

1. The first year will supply all fatigue parties required by the Engineering Society Executive. These parties will be detailed by the first year executive.
2. The first year will provide one man daily to report to the President of the Engineering Society for whatever services may be required. (Members of the first year Executive Club and Engineering Society Committee are excluded).
3. The East door of the Engineering Building shall not be used by any freshmen.
4. Freshmen must not wear SPATS or DERBIES.

The following rules must be observed up to the time of the School initiation:

1. All freshmen will wear a green tie of the style, approved and supplied by the Supply Department of the Engineering Society.
2. All freshmen will enter the school buildings by the basement doors only.
3. Freshmen will remove their hats in all school buildings.

The initiation will be held the first week in November.

These rules go into effect for the first time next year. As to their success and whether they, along with the inside initiation, will produce the required result is at the present time a matter of doubt—but time alone will tell.

W. E. BENNETT, 2T3,
Chairman Frosh Rules Committee.

SCHOOL OF SCIENCE NGYNYRS SPaSms COMMITTEE, 1920-21.
Back Row:—D. L. Pratt, 3rd Year; J. M. Dymond, 1st Year; R. M. Prendergast, 4th Year; W. D. Jewett, 2nd Year.
Front Row:—D. Macbeth, 2nd Year, Chairman; Craig Hamilton, 3rd Year, Ex-officio.

## REPORT OF THE CONSTITUTIONAL COMMITTEE

The President, University of Toronto Engineering Society.

Sir,—Acting on instructions from the Executive, this Committee has carefully studied the old Constitution and herewith beg to submit to the members a draft of the revisions we have seen fit to make. We trust that these will meet with the approval of the members of the Society.

The following are the more important changes made:—

1. The arrangement of sections has been somewhat changed and they now appear in proper order.
2. Various articles have been changed to a different section.
3. Fee for life members has been done away with.
4. Representation on *Varsity* staff is left to the discretion of the Executive.
5. All references to a Permanent Secretary, Manager or Editor-in-Chief have been deleted due to discontinuation of the publication of *Applied Science.*
6. Provision has been made so that the federation of clubs may be extended to include all "School" activities.
7. Provision has also been made to financially assist the clubs if necessary.

The aim of the Committee has been to make the Engineering Society more united and thus strengthen its hold on all its members.

The thanks of the Committee is extended to the Faculty Committee on Engineering Society affairs for their constructive criticism of this effort.

J. F. YOUNG,
Chairman, Constitutional Committee.

### Committee

| | |
|---|---|
| R. W. Downie, | President of the Society |
| J. F. Young | Chairman |
| J. Farley | Recording Secretary |
| A. L. S.Nash | Third Year Representative |
| C. S. Sneyd, | First Year Representaive |

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## THE STUNT NIGHT COMMITTEE EMBODYING THE PRODUCTION OF "SPASMS" BY THE NGYNYRS

### Organization

THE ENGINEERING SOCIETY EXECUTIVE appointed as a nucleus for a Stunt Night Committee the following men:—H. G. Thompson, III. Yr., Ex-officio Chairman; D. MacBeth, II. Yr., Chairman; C. Hamilton, III. Yr., Ex-officio.

During the fall term the rush of events claimed the attention of the student body to such an extent that it was only possible for the above-mentioned officers to complete a committee.

At first the conception was a Central Committee on which would be a Chairman and a representative from each year, who in turn would be the Chairman for a year Committee.

The Central Committee was augmented accordingly by the following men, who were to be Chairmen of their year sub-committees: IV. Yr., R. M. Prendergast; III. Yr., D. L. Pratt; II. Yr., W. D. Jewett; I. Yr., J. M. Dymond.

The sub-committees, however, never materialized, owing to the fact that the departments were too isolated, and a representative year committee was impossible.

Forthwith the Central Committee proceeded to canvass the years through the year representatives, with the result that a programme was prepared. At this stage the Committee were brought to an abrupt stop. The organization of the Stunt Night Committee was *not* one which permitted the production of a show, therefore the producing of "Spasms" passed from the control of the Stunt Night Committee to the hands of the staff of the Ngynyrs. The staff was as follows:—Director and Stage Manager, C. T. Carson, II. 6; Musical Director, C. Hamilton, III. 6; Business Manager, D. MacBeth, II. 6; Master Electrician, A. Wilson, IV. 7; Master of Properties, S. T. Franks, II. 7.

### Production

(*a*) **Staging**—The question of the hall was primary. Hart House Theatre was too small, as the intention was to run the show but one night owing to the late date set, March 2nd. Convocation Hall is absolutely unfitted for the production of any event which requires scenery. Massey Hall seemed to be the ideal place. True, there would be expenses in connection with it, but then, the understanding was, that as long as "Spasms" paid for itself, the choice of a hall at any price did not matter. Accordingly, Massey Hall was engaged.

Due to the fact that there was little time for rehearsals, Mr. Carson, the Director, felt the need of assistance on rehearsing and producing the show, whereupon Mr. Thomas McKnight, a well-known director, was engaged.

Some of the skits required properties and costumes. Wherever possible, the Business Manager and Properties Master obtained these from local firms in return for advertising space.

All costumes which could not be obtained otherwise were hired.

Scenery was obtained at a flat rate from Mr. Chas. Gallagher of the Royal Alexandra Theatre. He also supplied two men to handle, install and remove same.

(*b*) **Business and Advertising**—Business policy was to keep expenses as low as possible. To do this, advertising on the programme was given as payment for as many "properties" as possible.

Advertising was handled through *Varsity* to the students, and through the E.I.C., A.S.M.E., A.I.E.E. outside of the University. No advertising was done through the local papers, on the assumption that the returns would not justify the expenditure. More concentrated effort was made to reach graduates and professional engineers, which brought better results, since the invitation to attend was personal. Since this was the first "Spasm," complimentaries were sent to the "School" professional staff to ensure their attendance, and to let them observe that the students had not spent their time in vain.

### Treasurer's Report.

**Expenses—**

| | | |
|---|---|---|
| Massey Hall | $198 13 | |
| Scenery | 75 00 | |
| Mr. McKnight | 50 00 | |
| Printing (Programmes) | 40 80 | |
| *Varsity* Advertising | 30 75 | |
| Printing (Tickets) | 11 35 | |
| Photo Engravers | 5 87 | |
| McKenna, costumes, wigs, etc. | 5 05 | |
| Cartage, Mr. Wilson | 34 25 | |
| | 7 00 | |
| Cartage and skit, Mr. Hamilton | 3 65 | |
| 2nd Year skit and music, D. McBeth | 9 75 | |
| Trimmings, Mr. Franks | 7 65 | |
| Music—Mr. Maunder | 95 | |
| Music—Mr. Hamilton | 1 00 | |
| Hipp.—Services—Mr. Carson | 5 00 | |
| | | $486 20 |

**Other Expenses—**

| | | |
|---|---|---|
| Feb. 8—Envelopes, O. D. J. | 30 | |
| Feb. 10—Signs—McBeth | 2 00 | |
| Feb. 13-25—Stamps, O. D. J. | 16 | |
| Feb. 15-16—Car fare, McBeth | 45 | |
| Feb. 17, 19, 25, 26—O. D. J. | 45 | |
| March 3—Franks | 1 00 | |
| March 8—O. D. J. | 25 | |
| Feb. 26—Tip, Sec. Office Boy | 25 | |
| Feb. 26—Comp. tickets tax | 2 20 | |
| Cheque book | 25 | |
| Music, Mr. Grant | 1 70 | |
| Cartage—Supt's. Office | 75 | |
| Cartage, Mr. Moore | 4 00 | |
| | | $ 13 76 |
| | | $499 96 |
| Refund from Mr. Franks | | 1 00 |
| | | $498 96 |

**Tickets Sold—**

| | | |
|---|---|---|
| Massey Hall | 25 | |
| Engineering Society | 820 | |
| Engineers | 125 | |
| Hart House | 36 | |
| By different members of Committee | 15 | |
| | 50 | |
| Mr. Dugal (Money left at Eng. Soc.) | 10 | |
| Mr. McManus (extra) | 4 | |
| | | 1085 |

**Complimentary—**

| | | |
|---|---|---|
| Staff and members | 60 | |
| Press | 12 | |
| Orchestra | 44 | |
| Cast, Committee, etc. | 142 | |
| | | 258 |
| | | 1343 |
| Tickets exchanged | | 1301 |
| Tickets unexchanged | 42 | |

**Received from Sale of Tickets—**

| | | |
|---|---|---|
| Mr. G. T. Clarke | $ 27 50 | |
| Mr. Ambrose | 3 00 | |
| Mr. Mullins | 5 00 | |
| Mr. Roberts | 9 50 | |
| Mr. Muir | 6 50 | |
| Mr. Caldwell | 10 00 | |
| Mr. Hamilton | 1 00 | |
| Massey Hall | 12 50 | |
| Hart House | 18 00 | |
| Sold O. D. J. | 7 50 | |
| Mr. McBeth | 25 00 | |
| Mr. McManus | 2 00 | |
| Engineering Society | 349 00 | |
| Engineering Society | 66 00 | |
| | | $542 50 |
| Expenditures | | 499 96 |
| | | 42 54 |
| Refund | | 1 00 |
| Surplus | | $ 43 54 |

All the items are not covered by receipts, but the main ones all are. You will note that there is a surplus of $43.54, which amount I have turned over to the Engineering Society.

J. L. JOHNSON, Treasurer.

## Summary

In summarizing the report, perhaps it would be well to remark on the various difficulties encountered, and the solutions arrived at by the staff. These are:—

(1) **Time**—The time for the production of "Spasms" in the future should logically be the Fall term. Then the student body is more willing to lend time and effort to an endeavor than at any other time. Therefore, we strongly advise that in the future "Spasms" be a fall term event and the production of "Spasms" in the fall term should make it a 50 per cent. better show.

(2) **Localism**—Every endeavour was made to prevent "localism." It is the curse of the amateur production, and what could be more boresome to a gathering of graduates at an Alma Mater event than the production of a whole show based on localism of which they know nothing?

(3) **Tickets**—We strongly advise that in the future all seats be sold *without reservation by years*. The following reasons may satisfy the arguments for such a procedure as was followed this year:

(*a*) Those desiring seats together merely gave their tickets to a single individual who obtains a block of seats together.

(*b*) The exchange ticket system which was used this year permits the above.

(*c*) Those to whom the best seats were forthcoming this year had the poorest. For instance, the 4th year were at the rear downstairs.

(*d*) Perhaps the best policy would be to give to the graduating year the privilege of a block of the best seats in the house reserved. Then the others could get theirs by block system through exchange tickets. The quality of their seats being influenced only by their desire to see the show. If one desires to get good seats under the Open House Exchange Ticket System, one only needs to secure those seats early in the seat sale. The policy to award to the graduating year a block will come to each year in turn, and so favor no one.

(4) **Awarding the Cup**—In awarding the cup for the best skit this year difficulty was experienced in securing the dramatic critics, owing to the fact that their tickets were mislaid. Consequently, an adequate criticism was not available. However, we feel that we have scored this year the best faculty stunt night staged, and we recommend that "Spasms" be continued along the lines of a revue, for the simple reason that the experience gained by the participants will be more in the line of real stage experience, and in so doing the tendency will be to produce a *whole show*, rather than a number of "local" skits. The advan-

TOIKE OIKESTRA, 1920-21.

Back Row:—P. S. Davidson, J. J. Crawford, H. F. Robertson, R. R. Parker, M. L. Rundle, Treasurer; F. J. Lavender.
Centre Row:—R. K. Scott, G. A. Thompson, H. R. Fardoe, T. M. West, Secretary; G. H. Voaden, Librarian; P. S. Edwards, L. J. Bonham, J. Buchan.
Front Row:—H. A. Jackson, J. R. Kirkconnell, S. R. Muirhead; G. D. Maxwell, C. Hamilton, President and Conductor; H. G. Thompson, J. S. Mayberry.

tage of this tendency lies in the fact that the show becomes one which will appeal to graduates as well as undergraduates.

Therefore, we strongly recommend that the cup be given for skill and execution of parts rather than for *subject matter*, and in so awarding the cup—all secret rehearsing will be eliminated, and the show can be rehearsed and directed by a Director—tending to give a better rehearsed and more cohesive production.

(5) **Productions Staff**—We recommend that instead of a Stunt Night Committee, a Spasms Professional Staff be appointed directly by the Engineering Society. A Committee would be forced to organize a production staff in any event, and the intermediate committee is unnecessary. We submit the following "Production Staff" outline for "Spasms II.":

Professional Staff of "Spasms"—Director and Stage Manager, Assistant Stage Manager, Business Manager, Publicity and Advertising Manager, Musical Director, Master of Properties, Electrician, Treasurer.

In closing our report we beg to submit that our "Summary" with suggestions, is only introduced in the text of the report because of the fact that the matters considered are the chief difficulties encountered in breaking the road to an annual "Spasm," and we wish to pass on these observations as the result of experience, in the hope that they will be of use to the Productions Staff of "Spasms II."

## TOIKE OIKESTRA.

THE conclusion of the session 1920-21 brings to an end the second year of the orchestra's work since its reorganization following the war. On the opening of School last fall little time was lost in getting under way, and practices were commenced, under the leadership of Mr. C. Hamilton. It was found that there were about twenty men in the various years that were willing to give their time and talents to this branch of School activity. Practises were continued regularly throughout the year, and it is only fair to say that, to a large extent, the success of the orchestra is due to the faithfulness of the individual players in turning out to these rehearsals.

At the organization meeting the following executive was elected: President and Conductor, Mr. C. Hamilton; Secretary, Mr. T. M. West; Treasurer, Mr. W. L. Rundle; Librarian, Mr. G. Voaden. The brunt of the work fell on Mr. Hamilton, and the thanks of the orchestra are due to him for the way in which he took charge.

The orchestra, besides playing at Engineering Society meetings when required, performed at the following functions during the course of the year: Engineering Alumni reception and dinner, Engineering Society dinner, E. I. C. smoker, Farmers' Winter

Course dinner, concert given at St. Paul's Methodist Church, and "Ngynyrs Spasms." It was at the last named that the orchestra scored its greatest triumph, and demonstrated to the public what it really could do. The greater part of this work was done gratis, but one or two donations were received for the orchestra fund.

The nature of the work the orchestra was called on for was mostly of the light, popular variety, but for the concert given at St. Paul's a higher standard of music was provided.

Those in charge would also like to take this opportunity of thanking the Engineering Society for the backing that they have given the organization. Through their generosity the orchestra have been able to procure a set of drums and a number of music-stands of their own that has greatly facilitated the work and increased the efficiency of the organization.

## THE SPaSms CUP

To promote a healthy spirit of rivalry between the various groups presenting sketches wth the NGYNGRS in their annual SPaSms, the Engineering Society have donated a handsome silver cup, suitably engraved, as a perpetual challenge trophy. Realizing the merit of single or team performances, they have this year instituted the practice of donating a prize for the best of these. The individual prizes, which took the form of gold-filled lockets with the School pin set thereon, were won by Messrs. Grant and Walker. The Committee of judges, after a considerable amount of deliberation, awarded the trophy to 2T2 for their "Krazy Cabaret."

The following are the rules for the competition as drawn up by the Executive:—

The Cup shall be a perpetual challenge cup to be held by the Year or Club presenting the best number with NGYNYRS in SPaSms.

The award shall be based on the following conditions:—

(*a*) The cast shall consist of three or more performers.

(*b*) The general excellency of the production rather than the originality of the dialogue shall be the object sought.

(**c**) The contestant shall at all times comply with the instructions of the officials, such as stage manager, censor, etc., appointed by the Executive.

(*d*) The Executive shall appoint annually a board of at least three judges of which the President of the Society shall be one.

(*e*) In case of dispute the President of the Society shall decide on the correct interpretation of these rules.

The individual prize or prizes shall be awarded to the best number put on by not more than two performers, and shall take such form as the Executive shall decide.

SCHOOL OF SCIENCE HOLDERS of "T's"—1920-21

Insets:—W. B. Ramsay, '22, Hockey (Capt. '20-21). A. W. Carew, '23, Rugby.

Top Row:—K. L. Carruthers, '22, Track (Capt. '21); C. A. Hughes, '20, Rugby; G. E. Lindsay, '23, Swimming, (Capt. '20-'21); J. R. Gilley, '21, Soccer; M. D. Earle, '23, Rugby; F. C. A. Houston, '22; Rugby; G. R. Gouinlock, '21, Hockey; A. A. Bell, '23, Rowing.

Centre Row:—J. C. Perry, '22, Wrestling; G. F. Evans, '22, Hockey; J. B. Hamilton, '21, Rowing; F. R. McDonald, '21, Pres. S.P.S. Ath. Assoc.; Prof. C. H. C. Wright, Hon. Pres. S.P.S. Ath. Assoc.; F. S. Seaborne, '23, Boxing; H. S. Spencer, '21, Tennis; W. J. Nichol, '20, Hockey.

Bottom Row:—G. L. Magee, '21, Rowing (Capt. '20-'21); W. S. Sherk, '22, Wrestling; G. G. Duncan, '23, Rugby, Capt. '21); J. M. Breen, '21, Rugby (Capt. '19-'20); R. D. Heustis, '20, Gymnasium; G. R. Workman, '10, Gymnasium; P. F. McIntyre, '21, Hockey; E. G. Rolph, '23, Rugby.

APPLIED SCIENCE AND ENGINEERING ATHLETIC ASSOCIATION EXECUTIVE, 1920-21.

Back Row:—J. G. Johnston, 2nd Year Representative; J. C. Perry, 3rd Year Representative; W. J. Parker, 4th Year Representative; W. S. Shirk, Secretary-Treasurer.
Front Row:—F. R. McDonald, President; T. R. Loudon, Hon. President; G. G. Duncan, Vice-President.

# SCHOOL ATHLETICS, 1920-21

By F. R. McDonald, *President Athletic Society.*

## Executive for 1920-21

| | |
|---|---|
| President | F. R. McDonald |
| Vice-President | G. G. Duncan |
| Secretary-Treasurer | W. S. Sherk |
| 4th Year Representative | W. J. Parker |
| 3rd Year Representative | J. C. Perry |
| 2nd Year Representative | G. Johnson |
| 1st Year Representative | Littlejohn |

SCHOOL has had an extremely successful year in the sporting activities of the University. Every Varsity team has had a large percentage of School men on it, and the old School spirit was never more predominant than it has been this year. Two Captains of Senior teams spend the rest of their time chasing knowledge at the old red schoolhouse, namely Joe Breen, Rugby; Beattie Ramsay, Hockey, and for next year we have G. G. Duncan as Rugby Captain and K. L. Carruthers as Track Captain.

No less than five championships were won by School this year, namely, Track, indoor and outdoor; Soccer, Rowing and Swimming. These five represent about half the inter-faculty sports of the University, and our teams in the Hockey, Rugby, Basketball, and other series all gave a very good account of themselves. Our Indoor Baseball team at the present is on top, and look like champions for this year.

School Athletic Executives have always labored under the difficulty of having to collect a voluntary athletic fee from the students, which has always been inadequate to properly carry on the work. This year's Executive, in co-operation with the Engineering Society, took a referendum vote on the matter of collecting a compulsory fee of $1 at registration from every student. This was carried by a majority of over 500, and the recommendation passed into the Faculty Council's hands, where it will, in all probability be sanctioned and thus come into force next session. This will give the incoming Executive, headed by Beattie Ramsay, about $800 to run affairs on, whereas this year we had approximately $400.

The Athletic Society is now one of the affiliated clubs of the Engineering Faculty, and hence the President is a member of the Engineering Society Executive.

It was thought probable that some friction might arise in future between the two Societies, so the Engineering Society Executive introduced a section XI. in their constitution whereby the Athletic Society has absolute control of its own affairs.

It is evident, then, that the Athletic Society benefit alone by this affiliation and it should also help to raise the status of the

Society in school life to the point where it should be.

In closing, on behalf of the Executive of 1920-21, I wish to thank you all for your support this year, and wish my successor, B. Ramsay, and his Executive, all possible success for the year 1921-22.

F. R. McDONALD, President, Athletic Society, 1921.

## Rugby

No sport at the University has had the same influence in **developing the physical side of the students** as has Rugby. It is a game where one must be absolutely fit to be a success, and long and strenuous training is necessary to make one so. Perhaps no other game requires such strict training rules as does Rugby. That these rules are beneficial to the physical side of our beings is quite evident from an inspection of Rugby devotees.

Joe Breen

The number of students at the University taking part in this sport runs into the hundreds, and there is plenty of room for all who care to play.

Last year there were in the neighborhood of one hundred candidates for the first and second Varsity teams.

The success of last year's Varsity team was largely due to the capable coaching of Laddie Cassels. He worked tirelessly day after day to round out a team that would be victorious, and his efforts were crowned with a well-deserved success. The Varsity team's strongest feature was their team-play, which was developed to the very highest.

The season of 1920 was a very successful one for the University of Toronto Rugby Club. The Senior team won the Intercollegiate Championship and the Dominion Championship, and the Intermediate team also won their Championship in the Intercollegiate.

In the Senior Intercollegiate series, McGill and Toronto were tied, and a play-off was necessary. This took place at Kingston, and Varsity were returned victors by a score of 16-6.

In the Dominion Championship Series, Argos and Varsity met in the finals, and Varsity won by a score of 16-3.

The Intermediates defeated Queen's in the final home-and-home series by a good margin, and their honors were well earned.

"School" put two teams as usual into the Interfaculty Rugby Series. While neither of these teams got into the finals, yet they gave a splendid account of themselves, and put up some grand games.

The Championship and the Mulock Cup went to Victoria, who defeated Senior Meds. in the finals.

That School failed to go farther in the Mulock Cup Series is, however, no disgrace. Her best players went to form part of the first and second Varsity teams, and thus her Mulock Cup teams were weakened.

Six of the 1st team regulars were School men,—Gordon Duncan, Ernie Rolph, "Tiny" Houston, "Happy" Earle, Artie Carew and Joe Breen. Quite as good a representation of School men were on the 2nd team.

However, this sacrifice was a willing one. To the honor of School and in exemplification of "that School spirit,"—now known all over the University,—we still say "Varsity first,—Faculty second."

"JOE" BREEN

## Hockey

"School" in hockey has acquitted herself nobly, having representatives on all three Intercollegiate teams, besides the two teams entered in the Jennings Cup series.

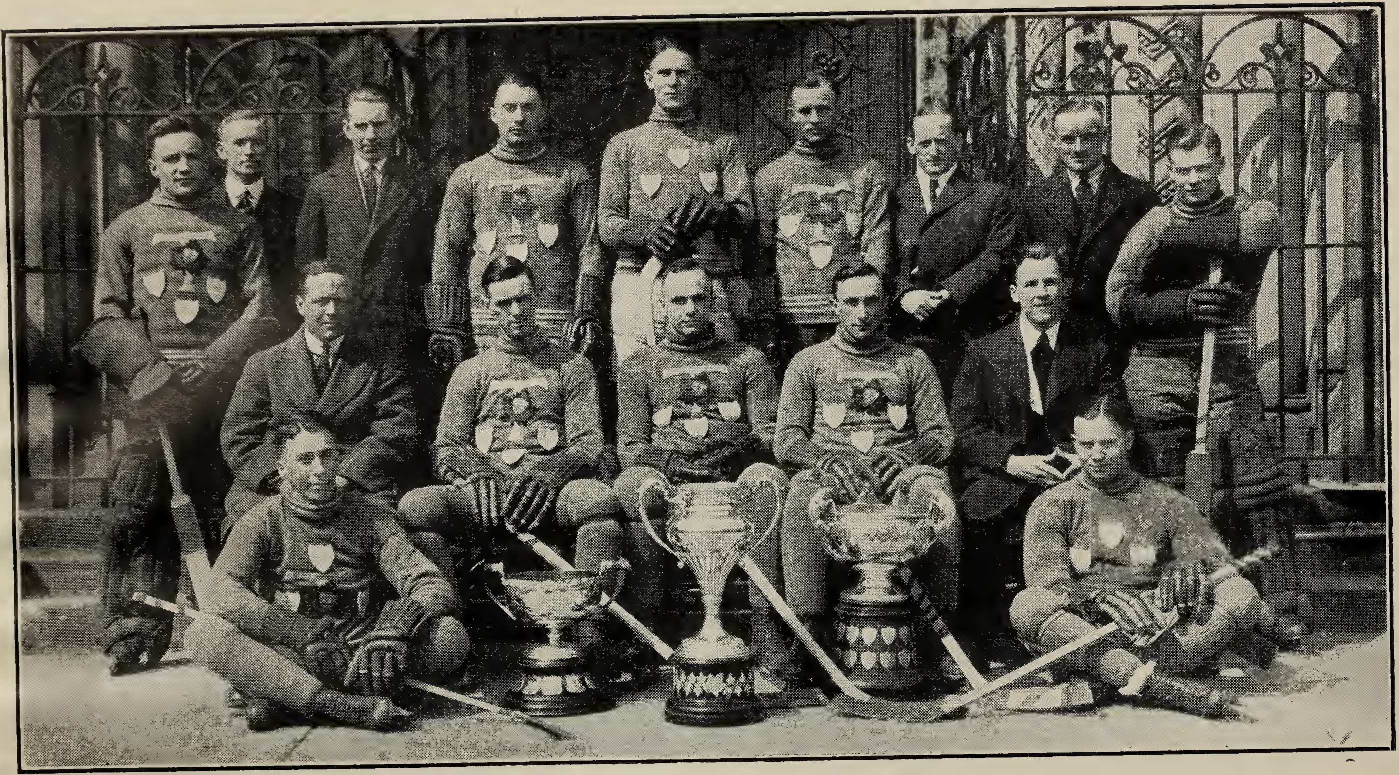
Everyone is cognizant of the success of the Varsity Senior team in both the O.H.A. and the Intercollegiate series. Of the total number of players on the team Ramsay (Captain), Sullivan and McIntyre hail from the little Red Schoolhouse. In all the team played thirty games, losing eight, three of these being exhibition games. In the Intercollegiate series the team won all four games, winning the Intercollegiate senior trophy for the sixth time since its donation by the Queen's University Hockey Club.

The O. H. A. schedule was a much harder contested affair. Varsity, having lost two games early in the season, were forced to win their final four games to qualify for the play-off with Granites for the J. Ross Robertson Memorial Cup. It was conceded by hockey critics that this was almost impossible, but, backed up by the good old Varsity spirit, 100 per cent. pure, they achieved the "impossible," earning the right to be known as the "Iron Men."

In the Allan Cup semi-finals Varsity played three games, winning all by a good margin. In the finals, played at Winnipeg on March 19th and 21st, the first game was lost to Brandon by a score of 2-0. This game was played on soft ice, which handicapped the lighter and faster Varsity team. In the second game, played on hard ice, Varsity justified the confidence placed in them by their supporters, by romping home on the long end of an 8-1 score, thus bringing the Allan Cup back to the East with a good margin of five goals.

S. P. S. was well represented on the Intermediate team by H. L. McCulloch (Captain), G. A. Thomson, F. R. McDonald, G. F. Evans and H. J. D. Wilford.

This team won their groups in the Intermediate Intercollegiate and Intermediate O.H.A. series. In the former they were



UNIVERSITY OF TORONTO HOCKEY TEAM, 1920-21

Standing:—J. H. Langtry; N. Lang, Trainer; F. R. MacDonald, Secretary-Treasurer; P. F. McIntyre, President; G. E. Westman; J. O. Olson; Dr. J. W. Barton, Physical Director; C. Smythe, Honorary President; J. T. A. Sullivan.

Back Row, Sitting:—Dr. A. B. Wright, Honorary President; Stan. Brown; W. B. Ramsay, Captain; W. J. Carson; Dr. W. A. Dafoe Honorary Coach.

Front, Sitting: E. N. Wright; F. G. Sullivan.

beaten in the finals by Queen's University by the small margin of one goal, while in the latter series they were defeated by Belleville in the second elimination round.

In the Junior series "School's" representative on the team was "Steve" Grey, of U.T.S. fame. This team was successful in winning the S.P.A. Cup, but in the O.H.A. series, after tying their group with De La Salle, lost out in a very stubbornly contested game. In the Intercollegiate play-off with Queen's University they tied their round, but in the play-off at Trenton were unsuccessful in their clash with the heavier Queen's team.

The season just past has been the most successful Canada's great winter sport has ever had. U. of T., in winning the premier honors, has much of which she may well be proud, and "School's" contribution to these honors has more than upheld the traditions of the "Old Red Schoolhouse."

## Basketball

For another year basketball is on the shelf, and School has failed to win the much-coveted Sifton Cup. If one had asked the Manager at the beginning of the season, what calibre of a team School would have, he would have told you a winning team. Now is no time for alibis, but why did School not win the Cup?

At the first of the season there were two chaps, Henderson and McLean, in their first year, who were well known in the basketball field. Due to some difference of examination, Henderson left School about the 1st of November, and went to Queen's University, where he played on the Intercollegiaate team of that University. McLean fared a little better, and stayed with School until the latter part of January. These were very serious losses for the Junior School team, and there is no doubt in Captain Jennings' mind that if School had been able to keep together the team that turned out at the first of the season, all would have been well.

In this article the team would like to thank the followers and supporters of the team for the way they turned out to the games. Still, they feel that if there had been a few more "Toike Oikes" in those crucial games against Dents, the tables might have been turned.

It must be remembered that the chaps who have been playing on the Junior School Basketball team are not one-sport men. In the fall, Johnston, Jennings, McBride and Hyland were playing rugby for Junior School; Meredith was on the track team, and Bell rowed in the Varsity eight.

Before the first game, Jennings of second year was chosen as Captain by the team. In selecting Jennings for this position, the team chose a man who takes as great an interest in interfaculty sport as any man in the School. For the past two seasons

SCHOOL OF SCIENCE SOCCER TEAM—INTER-FACULTY SOCCER CHAMPIONS 1920.
C. P. Breuls, W. V. Bishop, J. H. Browne, C. H. Lucas, L. D. Campbell, J. MacLellan, R. H. B. Cook, T. S. Glover, S. S. Smillie, Secretary; J. S. Morrish, S. W. Archibald, President; H. F. Wingfield, Captain; N. F. Johnson, Manager; E. S. Learoyd, W. R. Dunbar.

he has been playing on the Junior School rugby and basketball teams.

Junior School were grouped with Senior Meds, Junior Dents and Pharmacy. In the first game against Pharmacy School won by a one-sided score. The second game, which was with Junior Dents, was a nip-and-tuck affair. This was the only game McLean played in, and he showed up a star by scoring ten out of School's twelve points. The final score was 13-12, with School one point down. In the next game against Senior Meds, School won very handily, and the same punishment was meted out to Pharmacy. Then came the final game with Junior Dents. With the loss of McLean, the team knew they were in for a battle. From the first whistle School battled hard and were leading by one point, with one minute to go, when Dents scored a field goal, which won the game 11-10. The last game with Senior Meds was easily won by School.

Though this year has passed somewhat uneventful for the School basketball teams, we must look now for the material for next year's team. The defence players of this year were all first year men, and were the best defence School has had for a long time. A new forward line will have to be built up, as most of the men in those positions will be playing for Senior School.

It would be advisable for the men who intend to play basketball next year, to turn out with the Intercollegiate teams. This would give the players a good month's lead on the other teams, and it would also help make the Intercollegiate basketball teams a little more representative.

But let's look on this from the bright side. Let every man in School back the basketball team, so that next year, with the increased experience and knowledge gained by the players, we may bring home the Jennings Cup. The team: Forwards, Jennings (Captain), McBride, Meredith, Johnston; centre, Bell, McMillan; defence, Shields, Hyland, Gorky.

## Soccer 1920-21

When reviewing the athletics at Varsity during the past year and taking stock of the "silverware" which Science teams have won in the many branches of sport, it is well to remember the soccer team, which relieved the Dentals of responsibility for the Faculty Cup, and brought it back to its former place at School.

The schedule for last season divided the faculties into two groups: Meds, Victoria, Wycliffe and Science forming one, and Knox, Pharmacy, Veterinary, with Dents, last year's champions, in the other group. University College did not enter a team.

In their group Knox won out, playing some fast games, but managing to come out first in them all. The Science team also claimed the same record, so there was little to choose between

SCHOOL OF SCIENCE TRACK TEAM, INTER-FACULTY CHAMPIONS, 1920-21.

H. A. Oakes, G. Rumble G. E. Steel, H. J. Meredith,
H. R. Burton (Capt.) K. L. Carruthers (Mgr.)

the two teams when they met in the finals for the cup. The first game of the finals was an exhibition of as fine soccer as has been seen in the series since the war. Both teams worked hard for the full sixty minutes, but School managed to come out on the long end of a two-to-one score. In the second game School elected to play a defensive game, and although hard pressed at times, succeeded in maintaining their one-goal lead by a no-goal game, thus winning the round and the cup.

As in all sports, Science supplied a full share of men for the Senior and Intermediate teams, there being three on the Senior and seven men on the Intermediate. The Senior series was short, there being only two games played, one at Kingston, which resulted in a tie, and one here, when Queen's were defeated, giving the championship to Toronto. The Intermediates played a series with McMaster, City Teachers and O.A.C., and by defeating O.A.C. on the back campus by a one-nothing score, proved that they were the best.

The season was productive of a class of sport in all three series which should go far to bring soccer back to the position it once occupied as one of the foremost sports at Varsity. Next season it is expected that Varsity will put a team in the T. and O. Cup finals. The games will be played at the Stadium, and should fill out the season and arouse some much-needed enthusiasm throughout the University. In the inter-faculty series, too, there is promise of keen competition. It will remain to the Junior years of School to turn out men who will fill up any gaps in the ranks of last season's team, and produce an eleven which can show our motto, in so far as the Faculty Cup is concerned, to be, "What we have we'll hold."

## Track and Field—Harrier

The year 1920-21, as far as the track team is concerned, has ended in a blaze of glory, and left the mantle of victory resting securely where it belongs, on the shoulders of the School of Science men.

Continuing their double victory of last year, the School track men pulled off a win in both the outdoor and the indoor interfaculty contests. The outdoor meet was a fight from start to finish, our old rivals, the Meds, running us close. The great work in the sprints of Joe Breen and Rumble, ably assisted by Meredith, McIntyre, Burton and Steel in the field events, saved the day. S.P.S. were without the services of last year's individual champion, who was unable to compete, owing to injuries in rugby.

The indoor meet did not bring out so many School men, but two or three of the old guard turned back all opposition, winning half the events, the individual championship, and breaking four records in addition. Arts gave us a great battle here, too, and were only four points behind at the end of the season.

The Intercollegiate meet in the fall went to McGill for the second time in succession. The School men on Varsity's team included Breen, Meredith, Steele, McIntyre and Carruthers; but even with their aid Toronto found that McGill had a better-balanced team. Oddly enough, the events Varsity captured in 1919 went to McGill this time, and vice versa.

The track chances for next year are bright. School and Varsity lose several stars who graduate, but younger men are developing rapidly. Nearly all the candidates for our team next year have promised to get off to an early start by turning out by September 15th.

In distances above 220 yards School is weak, so it is no surprise to find Meds winning the Interfaculty Harrier Meet, and providing, with the addition of Leigh of Wycliffe and Stevenson of Dents, the team which so handsomely beat McGill in the Harrier Meet held here. These men are in their junior years, and we should win the Harriers for the next two or three times, at least.

## Tennis

Since the war, tennis, like other sports, has flourished, and its popularity is shown by the entries in the undergraduate tournament which have numbered well over one hundred. The year following the war saw Varsity represented by an exceptionally strong and well-balanced tennis team of six men at the Intercollegiate Tournament in Montreal. The U. of T. racket-wielders showed their superiority by winning the tournament by a wide margin. During the last college year, however, McGill was able to put in the strongest tennis team which probably ever participated in a Canadian Intercollegiate tennis championship, with the result that although the Varsity Tennis Team was a very strong aggregation, the McGill team won the tournament.

The under-graduate tournament was held early in October at the Rusholme Lawn Tennis Club, Dovercourt Road, and was handled very successfully, although there were over one hundred entries in the singles and over sixty in the doubles events. The team was chosen from the semi-finalists in the singles and doubles, with the right of any player who had been eliminated to challenge a proposed member of the team for his place on the team. The tournament resulted in the defeat of Wales by Richardson in the finals. Some excellent tennis was the result, and the team finally chosen was made up of Sheard, Spencer, Richardson, Allen, Wales, Phillips, and Williams. Especial mention should be made of the playing of W. Crossen, who, in his first year, reached the semi-finals by playing consistent tennis and defeating several experienced players.

The Intercollegiate championship was held the following week at Rusholme Club, Varsity's opponents being Queen's and McGill. On the McGill team were two very brilliant players who carried all before them, and after some splendid tennis, the championship went to McGill.

## Swimming

In Swimming, as in all other branches of sport, the reputation of the Science Faculty was creditably upheld. Besides winning the Interfaculty Swimming Championship, School had four men on the Intercollegiate team, and five men on the Intercollegiate Polo team. Swimming is getting back to its own at Varsity, and it is our Faculty that is doing the most to put it there. To help the swimming movement, the Fitzgerald Trophy for interfaculty competition was presented to the University this year.

School had strong teams in the Water Polo series and the Swimming meet. Although playing a superior brand of ball, they lost by the narrow margin of two goals in the final polo game with Dents. But in the Swimming meet the results were reversed, the Science team winning more points than the combined scores of their two nearest rivals. George Lindsay broke one record at this meet when he romped away from Frank Wood in the 100-yards speed.

The team:—George Lindsay, 2T3, Captain of the Intercollegiate and School teams; 1st in the 100 yards, tied for 1st in the 50 yards; Toronto's fastest sprint swimmer. H. Keffler, 2T4, tied for 1st in the 50 yds; 3rd in the 100 yards; Ontario 100-yards champion (won at West End, March 19, 1921). C. Harston, 2T3, Captain Intercollegiate Polo team; 2nd in the 200 yards, and 1st man on School relay team. A. Fitzgerald, 2T3, left forward Varsity Polo team; 1st in 50 yards breast. C. Wells, 2T3, Manager School Polo team; defence player Varsity Polo team; 1st 200 yards; Ontario 220 yards champion (won at Central, Feb. 28, 1921.) These men also played in the School Polo team. G. Mutch, 2T3, 3rd in Diving Contest, although handicapped by not having practised. A. A. Bell, 2T3, goal-keeper for the Intercollegiate and School teams; probably the best goalie in Canadian water polo. J. Langford, 2T2, Matson, 2T4, and Schinbein, 2T3, were the other three men who represented School in the Water Polo series. The last-named accompanied the Varsity Polo team to Montreal.

## Rowing

In the fall of 1919, Prof. T. R. Loudon, probably the greatest authority on rowing in Canada, and one of the most famous of Argonaut coxswains, considered the possibilities of directing the U. of T. after new championships in sport. The only rowing

S. P. S. EIGHT-OARED CREW.

Winners Inter-faculty Rowing Championship, October, 1920.

Standing:—B. Ramsey (3), J. H. Browne (Bow), J. A. Langford (6), D. M. Ross (4), R. M. McCabe (7), M. Wolsey (2).
Sitting:—H. M. Morris (5), F. A. McDonald (President), Prof. T. R. Loudon (Coach), G. L. McGee (Cox), A. A. Bell (Stroke).

requisites that Varsity possessed was Prof. Loudon's knowledge of the game and the spirit that brought the Grey and Allan Cups, among other championships, to Hart House. With this end in view, Prof. Loudon talked the matter over with three Argonauts, who were undergraduates, and it was decided to call a general meeting to see what could be done. The result was that Varsity now holds the rowing championship of Canada and the Hanlon Memorial Trophy is parked at Hart House among the other championships.

Every race in which a Varsity crew was entered, they won. A four-oared 140-pound crew, Coventry and Tufford of Meds and Hamilton and McGee of School, defeated everything in their class at the Dominion Day regatta on July 1st, 1920. A Junior four (heavyweight) won the final in their event, and incidentally broke the record. Geoff. Beatty of Arts was the original stroke of this four, but he unfortunately took sick a week before the race, so Strathy Hay, the stroke of the Olympic four, replaced him. The remainder of the crew were all School men—Boyd Little, Slim Bell and Doug. Huestis. Another Varsity heavy four, composed of Creighton of Victoria, Jack Smith and Happ. Earle of School and Dryer of Meds won their heat after a most gruelling race in which they trailed last until the final fifty yards, when they sprinted and won.

The famous Varsity eight was then formed, and a month later at the Canadian Henley in St. Catharines they defeated everything in sight. On the Friday, they defeated the Argonauts, Brockville, Hamilton and Ottawa , for the Junior championship of Canada, and on Saturday, the very next day, they won the Senior championship and the Hanlon Memorial, winning from Argos, Detroit, Ottawa and Chicago, by over four lengths. There were five School men in the crew—Boyd Little, Cliff Bennett, Jack Smith, Slim Bell and Doug. Huestis. The remainder were Coventry, Meds; Beatty, Arts, and Crighton of Victoria. Campbell, of Meds, was cox.

In the fall arrangements were made to hold inter-faculty races. School turned out so many candidates that the Argo clubhouse was nearly sunk. The final race was between School and Victoria. At the crack of the gun School jumped into the lead, and steadily increased it, winning by three lengths. The School crew were: Bell, McCabe, Jack Langford, Morris Ross, Beatty Ramsey, Wolsey and Brown. McGee, cox.

## Indoor Baseball

School has always played a major part in the various athletic activities of the University. The case of indoor baseball has been no exception. Last year representatives from several faculties met and drew up a schedule for an Indoor Baseball League.

In this league School entered two teams, both of which played good ball, one team unfortunately meeting defeat at the hands of St. Michael's in the finals.

Last fall indoor ball enthusiasts met and formed a regular Indoor Baseball Club, similar to the Hockey and Basketball Clubs. A schedule for the Interfaculty League was then posted, with eight different faculties entering teams. Mr. Love, of Spalding's, donated a cup for the champions, which enlivened the league, and made the competition keener.

School again demonstrated its affinity for good sport in entering two teams: a Junior team, made up of first and second year men, with C. Williams I., as Manager, and a Senior team, made up of third and fourth year men, with G. Winters III. as Manager. The formation of two teams in this way somewhat handicapped School, but the snappy quality of ball played by both teams attracted much attention from the fans.

In Mummery, Senior School possessed a pitcher without a peer in the league. To his blinding speed is added a real ability with the bat and good baseball brains. The rest of the team backed him up well, and it was indeed unfortunate that they lost out to St. Mike's by 4-2, after tieing them for first place in Group B. Junior School also met the same fate by losing to Trinity in the finals for the leadership of Group A. Mutch, Baird and Williams were best for Junior School, and if Mutch, their first-rate pitcher, had only been able to pitch all their games, there is little doubt but that they would have won their group.

School contains much good material, and with this year's experience ought to turn out a crack team next year which will bring back the cup.

Senior Team—D. Brody, A. E. Rolph, T. M. Barry, C. R. Mummery, J. H. Westren, G. Winter, J. E. S. MacAllister, W. L. Yack, W. W. Fitzgerald, A. Johnston, G. M. Broughall.

Junior Team—J. C. Mutch, H. Baird, E. Baird, R. Morris, A. Duncan, G. Thompson, M. McQueen, R. Williamson, C. Williams, W. Boyes, W. B. Jennings, D. McKendrick, K. Griffin, G. W. Beecroft, P. Wheatley.

## "School" and Squash

The present volume would be incomplete without some reference to the activities of "School" men in the sweat-soaked atmosphere of the squash courts. Those who have wandered idly through the maze of the lower regions of Hart House are familiar with the game. For the benefit of those who have not had this opportunity, and lest the idea of a well-known vegetable confuse the mind of the uninitiated, a brief description of the game follows:

The court has four walls, preferably at right angles to one another, for simplicity. Some lines are painted on the walls and on the floor. Two stout fellows armed with a racquet each, and dressed as scantily as they please, smite a small and rather hard (depending on where it hits one) rubber ball round these walls. The server stands with one foot near a line on the floor and sends the ball above the wall lines. It is considered a foul for him to reverse the process and serve with one foot on the wall, onto the floor, as this unexpected mode of attack gives the server an unfair advantage over his opponent. Each time one misses the ball or makes a bad shot, one's opponent scores a point. The game goes to the one who scores fifteen points first. Beyond that there are few rules.

The game has a splendid appeal to the mathematical mind, an easy familiarity with the laws of ballistics and the science of Euclid, being a great asset. At first when the game started at Hart House, a policy of "brute strength and apostrophied ignorance" was followed by many, but it soon became apparent that it was really a game requiring the greatest skill and the finest co-operation of hand and eye, nerve and sinew. Under these conditions, it is not to be wondered at that School has come out strong, as usual. A good proportion of the regular players are School men, and on the Varsity team of four which played R. M. C., winning both here and at Kingston, School was ably represented. A challenge issued by the Victoria College Senior Common Room to anyone, was accepted first by a School team, which succeeded in winning.

The game is in its infancy at Varsity and is capable of great development. It is undoubtedly one of the finest games played, and we look forward confidently to a time not far distant when there will be many more courts, so made that unlimited fresh air can etner, thus overcoming the only drawback to our game as played in Hart House now.

## U. of T. Billiards

Billiards is a game which has a fascination about it, as has anything about which there is a great deal to learn. To a great many people it is simply a case of "bang the balls around and trust to luck," but this is wrong. There is a science in billiards, which, if closely studied, involves very deep theory, and to the master mind probably Sir Isaac Newton's calculus may be introduced to solve some of the fine points of the game.

The Hart House Billiard Room at present contains eight tables, of which three are large English pocket billiards, two, small English tables, and three small tables, all of which are kept in the very best condition by two attendants of enviable ability. The chief attendant, Staff-Sergt. H. H. Roberts, Royal Grenadiers, is a crack rifle shot. He won the championship of Canada in 1910, has been on the Bisley team three years, and is accompanying that team to England this year, where, no doubt, he will display his ability.

Among those who frequent this room there are many undergraduates who partake of a great deal of amusement studying the finer points of the game, and the social intercourse is uplifting. Of course there are a few obstreperous youths who insist on throwing the balls about in order to let the fellows know they are present, but under the splendid supervision of the Billiard Committee, members of which are Prof. W. F. Kennedy (Chairman), Dr. Perry, Dr. C. C. Imrie, Mr. John Jennings of the Faculty, Mr. G. A. Elliott II., M., Secretary, and at least one undergraduate from each of the faculties of U. of T., good order and discipline is maintained.

In order to prove to the students that there are many finer points in billiards, which are of great interest, and to give them an insight into some of these, arrangements were successfully made last November by the Committee with the Brunswick Balke Collender Co., of this city, to install a championship billiard table in the large gymnasium, where on the nights of November 5th and 6th, matches were played between Mr. E. F. Cooke, amateur champion of Ontario, and Mr. Luke E. Leonard, amateur champion of Ulster, Ireland, and Fort William, Ont.—2,000 points. Cooke, 2,000 Leonard, 1,395. High breaks, Cook, 155; Leonard, 76.

Following this demonstration, a tournament was arranged for the undergrads who take an interest in the game, to take place in the Billiard Room. There were about sixty entries, and during the various rounds some expert ability was displayed. Mr. W. B. MacDonald, of Dents, the winner, and Mr. W. T. R. Bell, of S.P.S., the runner-up, were awarded suitable prizes for their excellent display.

Shortly after the second term opened this was followed by a handicap tournament for the championship of Hart House Billiard Room. The handicaps were decided by the Committee from the individual scores on the preceding tournament. H. J. Philp, of III. Yr. S.P.S., was the winner, playing from scratch. Mr. W. J. Boyd, who had a "25-point in 200" handicap, was a close runner-up.

# POSTSCRIPT

## The Engineering Society

After a dormancy of fourteen years TRANSACTIONS is again appearing. From 1907 to 1916 its function was performed by the monthly, *Applied Science*; since then, however, "School" has had no publication aside from occasional issues of *Toike Oike.*

Of the achievements of the Engineering Society during this academic year, few will receive the honorable mention, at the hands of future historians, that will be accorded the reappearance of the TRANSACTIONS. As we view it to-day, their most important accomplishment has probably been in re-establishing the Engineering Society on a firm financial basis, but that, in itself, must dwindle in importance with time; posterity will be quick to discount and ready to forget, hence the coming generations of "School" men would be deprived of a clear view of probably the most illustrious year the Society has enjoyed. By publishing this volume, the Executive has successfully perpetuated its good work; it will remain as a model for future Executives, long after this one is gone. Never did a year start with so many difficulties ahead, and finish with such bright prospects for the future.

* * * *

## No Apologies

The need for a publication of this nature had, of late, become acute. Enquiries from many pre-war subscribers, in different parts of the world, had been persistent; our own Alumni, we felt, would look with gratification on this connecting link binding them to happier, at all events, more care-free days, whilst we, the undergraduates, knew of no better way to line "School" up with the best of them. With these factors in view the Publication Committee set to work. The result of their efforts is in your hands. Do not be hasty in your judgment—not until you have made a survey of the problem as it faced them. The difficulties to be overcome were great. The phenomenal rise in the cost of publication, if not surprising, was, at least, aggravating, and lent no impetus to the scheme. The fact that none of the old Editors were with us to supply that wisdom derived only from experience, proved a great hindrance. Dealing with volunteer workers, men who receive no remuneration aside from the satisfaction of knowing that they have done their duty, has its advantages, but also some serious drawbacks. The first setback the Publication Committee got came as a resignation of four of its members,—a deplorable incident. Happily, the increased efforts of the remainder were well able to carry it through.

We do not desire to apologize for any of the shortcomings (and there may be some) of this issue; we believe it to be, if not exactly what the Frenchman would call *de luxe*, at least fairly passable.

* * * *

## Ye Editors

It is said that President Harding of the United States began his career as a newsboy. By dint of effort he became a printer's-devil, and finally Editor and publisher. Our Editor, though he is not eligible for the Presidency (not being thirty years old), is yet rapidly equipping himself for this honor. Being our chief, we dare not say much; we will but add that he has fulfilled the functions of an Editor, of a proofreader, of a printer's-devil, and, for all we know, he may be out at this moment, disposing of the copies.

We, being merely Managing Editor, are naturally exposed to much of the "menial," yet had it not been for the persistent help of our Editor, we would probably have had no need for this writing. Much praise is also due the Associate Editors, who unselfishly spent much effort to fill our advertising pages. Lastly, we wish to thank our advertisers for their generous response, and feel convinced that they will reap the benefits of their investment in a measure unhoped for.

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No. 35 1921-22

# The Transactions
of
# The University of Toronto Engineering Society

With which is incorporated the **Applied Science**

UNIV. TORONTO APPLD SCIENCE.

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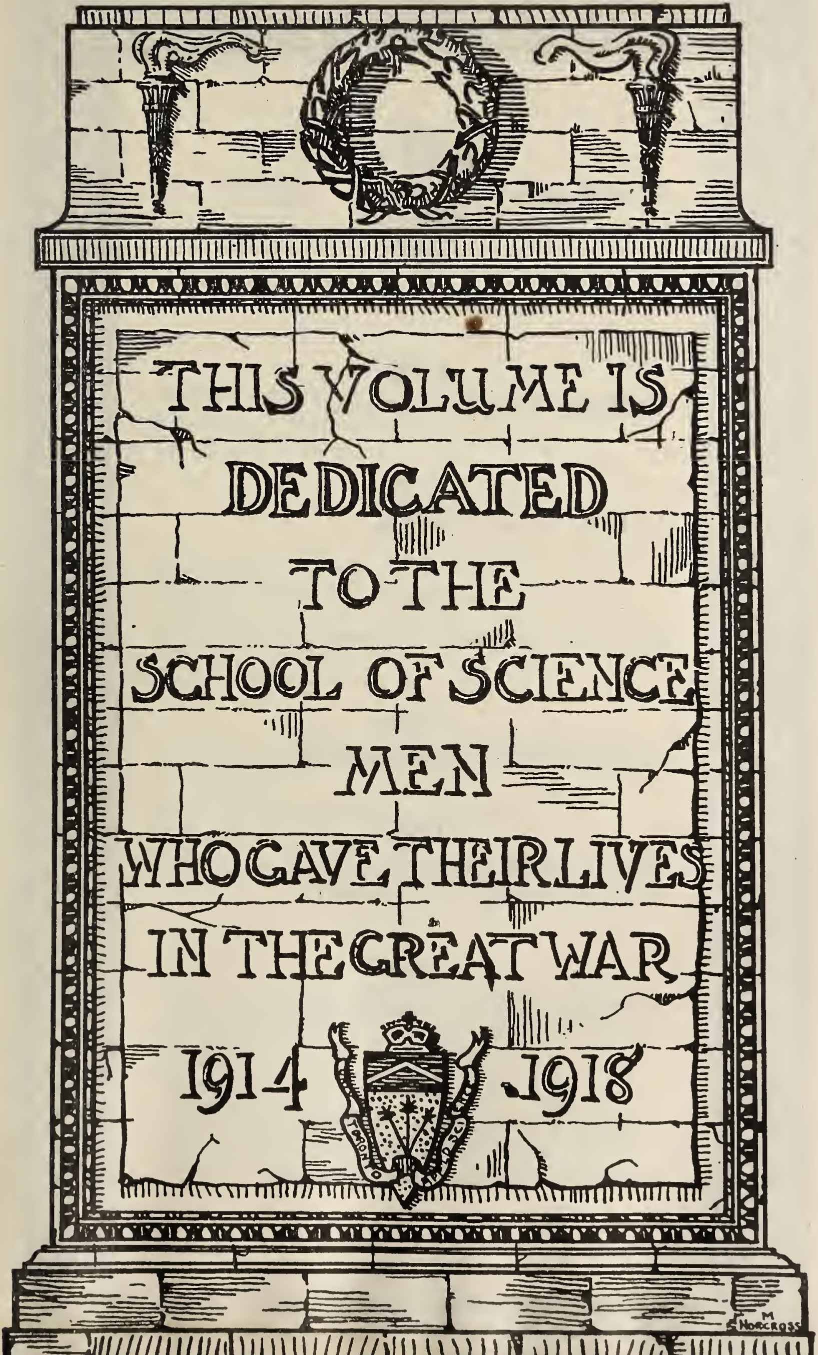

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WHO GAVE THEIR LIVES
IN THE GREAT WAR
1914 1918

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John Reginald Maguire.
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Henry Glassford Ward.

### 1920

Roy Andrew Hartrey, M.M.
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# Forward

The Engineering Society has passed through another successful year and it is now firmly re-established and revived after the War. The President and Executive Committee are to be congratulated upon the general success of the Society which is now in a flourishing condition.

.The business programme for the year appears to have been well conceived and very successfully carried out The several sections of the Society too appear to have had a successful year.

During the past year you have had a most useful and interesting series of addresses and papers on technical subjects which will prove of very considerable value not only to the graduates and members of the profession but to you yourselves as you are about to enter the active work of the profession. These addresses are now being put into your annual publication known as the Transactions of the Engineering Society and in this manner will be preserved for further use.

The present volume of the Engineering Society's Transactions will have a peculiar interest in a manner which will be distinctive this year and which will mark it as one carrying memories of the Great War in a manner peculiarly its own. When you started your session it was announced that you wished to keep particularly in mind the memory of those comrades who fell in the War, and this thought has been uppermost throughout the session as the Engineering Society has carried out its programme. This volume of Transactions is therefore dedicated to the memory of those splendid comrades who gave their lives and whose memory will always be preserved, not only by the Graduating Year, but by the Years preceding and following it. It occurs to me personally, and I am sure the same thought occurs to many members of the Staff of this Faculty, a great regret that as these post-war years go by the number of undergraduates who have seen service in the War is rapidly diminishing, and with the departure of this present graduating year there will leave these halls a large number of ex-soldiers who carry with them a wealth of memory which they will always have for their portion in the years to come. It is this memory which all of us who have been at the War retain and look upon as a possession of great value. It is the memory, however, of the splendid lives and achievements of our comrades whom we left behind in Flanders' Fields and whose example we will always remember, that will be our most cherished possession. As this book goes out to find its place amongst the graduates and the profession, it goes carrying with it this memory and this deep admiration which we had for those comrades who gave their lives so that we and Canada and the Empire might come through.

I heartily wish the President, the Officers and the Members of the Engineering Society all success and good fortune in now closing the present session, and I wish also to thank them for their hearty co-operation in connection with student matters generally with regard to the affairs of the Faculty.

March, 1922. C. H. MITCHELL, Dean.

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THE TRANSACTIONS of the
University of Toronto
Engineering Society
WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 35 TORONTO, APRIL 15, 1922 1921-22

# PROVINCIAL HIGHWAYS.*

By Geo. Hogarth, '09, Chief Engineer of Highways, Department of Public Works of Ontario.

ONTARIO has a system of Provincial Highways 1,812 miles in length which joins every city in the southern portion of the Province. These roads threading through the counties of older Ontario, serve as main routes of travel between distant points and at the same time are of benefit to local districts points and at the same time are of benefit to local districts market centres.

Roads in Ontario are supervised by various authorities and in order to give a clear view of the position of the Provincial Highways in the road development programme a short description of the different kinds of roads is necessary.

In the original surveys of townships, road allowances were left as concession lines, or side lines, around blocks of land, and the township council has authority over such roads which it builds and maintains, the province to aid the townships with the work grants a bonus of 20% of the cost of the work.

Throughout the counties there are many roads which serve as main market roads to towns, cities, and shipping points. Such roads are of more importance to the community than the township road, require better construction, greater width and stronger surface, and the counties have, therefore, been authorized to assume and construct a system of county roads. Usually about 15% of the road mileage in the county is taken as county roads and towards the cost the Government contributes 40% of the cost of construction and maintenance. Should some of the roads taken as county roads be important thoroughfares leading to towns and cities, or main routes through a county, they may be designated Provincial County Roads, in which case the Government contributes 60% of the cost of construction and maintenance.

---

*Address delivered before the Civil Club on Wednesday, Nov. 3rd, 1921.

In the immediate vicinity of cities all main roads require special attention to resist the heavy traffic and in the case of county roads for a distance from the city, a commission may be appointed by the county and the city to have charge of and build such main highways. The highways assumed are known as County Suburban Roads and are paid for, 30% by the city and county, and 40% by the Government. Very important suburban roads bay be designated Provincial Counyt Suburban Roads, in which case the city and county each pay 20% and the Government 60% of the cost of the work.

On provincial highways 80% of the cost of the work, together with all overhead charges and land required, is paid by the Government, and 20% by the county in which the road is situated. In the vicinity of cities, a certain mileage of provincial highways may be designated Provincial Suburban, in which case the city and county each pay 20% of the cost, and the Government 60%. Provincial highways are not designated entirely through towns but only extend into the municipality where the road is in front of farm lands. Where the continuation of a provincial highway passes through the business section of a town, the Government pays 40% of the cost of the central 20 feet of pavement laid by the town on the business street.

It will be readily seen that with the above system in operation, those roads requiring attention because of heavy and important traffic are so provided for that every facility for proper construction and maintenance is given.

The provincial county suburban roads, provincial suburban and provincial highways are all built to a high standard, with paved widths of 18 or 20 feet, with a full top width of road of 30 feet, and with adequate and effective drainage to protect the investment in surface. In addition, the provincial highway cross section provides a space for sidewalks on each side of the road, proper space for public services, such as rural free delivery post boxes, telephone, telegraph and power poles, also a location for underground services, water and gas.

The roadway portion of provincial highways is surfaced with material suitable for the traffic passing over it. Should the traffic be medium, a gravel road well drained and maintained, gives an economical surface, while for heavier traffic oiled macadam or penetration surfaces or pavements, such as asphaltic concrete or cement concrete, are provided. Because of the fact that the heaviest of traffic is found just outside cities, it has been found necessary in many cases to construct pavements as fast as ruling conditions permit, while on sections remote from cities, ditching operations, gravelling of long stretches and the bringing of the entire system up to a uniform standard are carefully attended to. In the year 1921, the Department of Public Highways graded 70 miles of road, gravelled 120 miles, placed macadam base on 33 miles, constructed finished macadam on 40 miles, bituminous macadam 17 miles, asphaltic concrete on 20½ miles, and cement concrete 25 miles, besides building 1,200 culverts and bridges.

To properly build a gravel road requires a dry roadway surface which in practically any location can be obtained by digging a ditch on each side of the travelled way. After the earth has been properly levelled and trimmed, a light coating of gravel about four inches in depth and 8 to 10 feet wide can be rapidly spread. This first layer should be carefully levelled and all stones raked ahead so as to be buried under succeeding loads of gravel. While gravelling progresses, the surface of portions completed should be kept smooth by means of the log drag, so that as the material is compacted it will be smooth for traffic. After the first layer of gravel has been consolidated in place, subsequent layers may be added as required, but in all cases care should be taken to see that the gravel is spread thinly to a depth of not more than two inches. Such a depth, properly spread and dragged and applied, if needed, spring and fall, will give excellent results. Gravel roads are readily built because over a large portion of Southern Ontario good road building gravel can be obtained on or close to the road and the cheapest of road building methods, intelligently applied, will give untold satisfaction.

**Concrete Pavement Between London and Lambeth.**

Macadam roads, being built of crushed stone, are usually desirable where traffic is heavy and where field stone or quarry stone can be easily obtained. In sections of the county where bed rock does not exist, field stone may be gathered into piles convenient for crushing, and portable crushers used to crack the stone to proper size.

In localities well served by railways and having commercial crushed stone available at reasonable rates, such material can be used to construct a two-course macadam, having large stone of about four-inch size in the base course, and two-inch stone in the top course. The lower course is usually five or six inches thick after compression and the top course four inches thick after compression. Surfaces of macadam roads are built with a crown of one-quarter to three-eighths inch per foot so as to give sufficient drainage.

Bituminous macadam surface consists of a depth of two-inch stone about three and one-half inches in thickness, into which hot tar or asphalt is forced under pressure. The stone is carefully levelled and may be given a light rolling before penetrating. If tar is used, it is heated to about 250° F. and if asphalt, to about 350° F. In the first application, about 1½ gallons of bitumen per square yard is used, and while the material is still hot and soft, stone chips are spread rapidly over the road surface. The roller is then passed over, a second light coat of bitumen applied at a rate of about one-half gallon per square yard, then a light coat of stone chips applied and, after a thorough rolling, the roadway may be opened to traffic.

Asphaltic concrete surface is laid in two courses each 1½ inches thick, on either a good macadam or concrete foundation. The lower course of the mix uses sand and coarse stone up to about half an inch in size, while the top course may contain only a well graded sand. The upper or lower course is mixed separately in an asphaltic mixing plant and about 11% of asphalt is sufficient to give good results. Such pavements will carry the heaviest of traffic and give service over a period of years.

Concrete pavements may be constructed of cement, sand and good gravel or crushed stone in the proportions of 1 part of cement to 1½ parts sand to 3 parts gravel or stone. The thickness at the sides is usually six inches and eight and one-half inches in the centre.

Transverse expansion joints may be left every 50 feet and in some cases a longitudinal centre joint may be desirable. Good results under heavy service conditions may be confidently expected from any well laid concrete pavement.

Structures on provincial highways are built to carry Class C loading, the concentrated load of which is a 20-ton road roller. Spans of from 2 to 20 feet are built of concrete with flat slab reinforced top. Longer spans are steel girders or trusses. The clear width of roadway is 24 feet, or greater if special conditions demand, and if the bridge is in or near a large centre, one or more sidewalks 6 feet in clear width are provided. All culverts are built of such a length that the full 30 feet of top width of road can be placed between the end walls.

Where excessive grading is not required, the maximum grade on the provincial highways is 5%, but in exceptional cases this may be increased to 7%, which is as steep as any highway grade can safely be.

Every effort is being put forward to make the highways attractive by tree planting and attention to the roadside so that people will be drawn to the main roads and tourist traffic be encouraged as it is one source of revenue needing development.

The highways entering the cities are being attended to immediately and surfaces completed so as to serve those portions of the system which have the heaviest of traffic. To finish such pavements requires, in many cases, bridges, and new locations for main roads to give direct access to large arteries of travel in the cities.

The highways now completed are giving efficient service to sections of the country which urgently required rapid transportation, and as fast as public opinion and finances permit the benefits of such construction are being given to an ever widening area of the Province of Ontario.

---

## ENGINEERING AND TRADE WITHIN THE EMPIRE.*

By Brig.-Gen. C. H. Mitchell.

LAST year at the opening meeting of the Engineering Society I spoke on engineering activities in Canada. To-day I felt that there was rather a new phase that would be interesting. I want quickly to run over the engineering activities in Canada and then to go farther afield and consider the Empire and our relation to it.

Canada has come through a long period of development. Sir Robert Borden, speaking here lately, traced out the development of autonomous government in Canada from the beginning of British rule. In getting as far as we have, we must remember that although autonomous, we are still in the Empire and must think of Canada as part of the Empire.

Applying that idea to engineering, Canada was at first entirely dependent upon other countries for engineering products and developments. At the beginning of the war we were at the peak of ordinary development. The war developed us in a different direction. We must take up peaceful development again and make use of our abnormal war development for that purpose.

---

*The Dean's opening address to the Engineering Society, October 26th, 1921.

During the past fifty years the pendulum has swung many times. It is now swinging towards the Empire again and we are entering a period of great commercial activities with the Old Country. During the Summer a congress of the universities of the Empire was held in England. This gave me the idea that Canada has a very large part to play in co-operation between students and teachers throughout the Empire. An Empire policy has been evolved in England by Lloyd George which provides for the continuance of that co-operation within the Empire which proved so effective during the war, in order to promote Empire trade.

## Engineering Activities in Canada.

I shall now briefly outline the activities in Canada at the present time in engineering fields. The first function of this country is agriculture—the production of food, and in that respect the engineer is second to the farmer. But farm produce must be transported and here at once the engineer comes in. There is not much work going on in the building of transportation lines at present, but much preparatory work is being done, e.g., docks, harbours, canals, terminals, etc. The whole question of transportation is very much in the air at the present time. The annual deficit of the railways taken over by the government is one of the greatest problems this country will have to face in the near future.

Highway construction is being carried out on a large scale in all the older provinces.

We are all familiar with the power developments going on around us, but we must not think that all the development is taking place in Ontario. Power development plants are under construction in Nova Scotia near Halifax, in New Brunswick near St. John, in Quebec, in Manitoba near Winnipeg, and two large plants in British Columbia.

Municipalities have gone and are still going through a period of difficult financing. There is very considerable activity, however, in the various phases of municipal engineering, such as water works, sewers, town planning, sidewalks, sanitary works, drainage, lighting, bridges, etc.

There seems to be a depression in the building trade at the present time, but there is some activity throughout the country, notably in Toronto, in Montreal and vicinity and in the Maritime Provinces. Very few large buildings are under construction.

Mining activities are still suffering from the depression following the war, but there are bound to be great developments, especially in those fields where prospecting was going on before the war and has now been resumed, e.g., northern Ontario, British Columbia, Labrador, northern Saskatchewan.

Considering the industrial world we find less employment than at this time last year; but we should not be discouraged, as a gradual improvement may be expected. Iron and steel, grain milling, wood products, cement, lime, clay, ceramics, brick, tile, are basic industries which must go on and will always provide work for engineers. Less basic industries are quiet, but showing signs of improvement. There is great mechanical activity in the manufacture of thousands of articles and also in the manufacture of electrical appliances.

If one considers the great variety of materials used, for example, in the new electrical building, one can realize the varied activity in the country in the line of building supplies.

The automobile industry has been overdone and there is a slump at present due to over production and lack of business.

The paper industry reached the top notch at the end of the war; there is a slump at present and prices are lower, but some construction is going on. The same remarks apply to the sugar refining industry. Business is very large, but as in the case of many other industries, it is suffering from losses on materials bought at war prices and sold at post war prices. Cane sugar is imported from the West Indies and the Orient and refined on both coasts. The business of equipping these refineries is going to form a large industry in Canada.

The oil business has received a big impetus from the discoveries in the MacKenzie and Peace River valleys. These may mean much in the next few years when a huge demand is going to arise for transportation purposes to replace coal.

In the field of chemical industry, in addition to all the industries already mentioned which may be classed in this way, we have the large munition plants at Trenton, Parry Sound and Weston now engaged in peace production. This shows the power of adaptation of the country and of its engineers and chemists.

### Empire Trade Relations.

In nearly all the industries and activities I have mentioned we can trace a connection with other parts of the Empire. Crude cane sugar and rubber are imported from the West Indies. Among imports from Great Britain are motors, ships. harbour equipment, water works equipment. Large gates for hydro development are obtained more cheaply from Great Britain than in Canada or the United States, also steel window sashes, metallurgical equipment, woollen and leather goods.

This means that Canada must adjust her business and engineering to Empire possibilities. Canada is in a direct line geographically between Great Britain and the East. The importance of this position is indicated by the appearance of freight trains crossing the country on express schedule carrying cargoes of silk valued at $2,000,000 from Japan to Great Britain.

## Britain's Post War Empire Policy.

The trend of post war policy in Great Britain is indicated by the proposals put forward by Lloyd George last week. They embrace three subjects. First, unemployment and relief—the giving of doles is to be stopped and work encouraged. Second—emigration to the Dominions—the right kind of emigrant is to be encouraged. Heretofore the difficulty has been to get suitable emigrants. Too large a proportion has been from the cities. The policy now is to send men from the country districts. Third—export credit—financial arrangements whereby firms overseas can do business with the Old Country, using a credit system not available heretofore.

These proposals mean the export from Great Britain of men of the right sort, materials, and money in the form of credit. Engineers should keep in mind that Canada must have people and money. These are now being put in our way by the new Empire arrangements, so that we can help both ourselves and the Empire. With this exchange of money, people, brains, and education, we are bound to have a prosperous period ahead of us.

## THE ENGINEERING INSTITUTE OF CANADA.*

By G. T. Clark, B.A., C.E., Designing Engineer Toronto Harbour Commission.

THE President of your Engineering Society has asked me to address the undergraduates in Engineering and gave me the privilege of choosing my own subject. I am going to attempt to tell you what I believe the Engineering Institute of Canada is doing, and can do, for the engineer of to-day, both graduate and undergraduate. The necessity for conserving and developing natural resources to the utmost is receiving world-wide recognition at the present time. The development and conservation of natural resources can reach a high state of efficiency and economy only by giving primary consideration to the conservation and development of man power. The man power of Canada is developed in one direction by an elaborate system of education, public schools, collegiate institutes and universities. A considerable sum of money is spent on every engineer that graduates from the University. He is intensively trained up to a certain point after which no one assumes any responsibility for his professional advancement.

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*Address delivered before the Engineering Society, Nov. 23rd, 1921.

I sincerely hope the time will come when the Federal and Provincial Governments will get some tangible return from the money invested in engineering education by applying the engineering man power so created to the development of industry and to the conservation and development of natural resources. Such procedure would certainly be in the public interest. In the meantime there is an organization at work trying to improve the value of the engineer to the community. This organization is known as the Engineering Institute of Canada.

**What is the Engineering Institute of Canada?** This Institute is the national body of Canadian Engineers, including among its members representatives of all branches of the engineering profession.

The scope of the Institute has broadened out materially since its name was changed from "The Canadian Society of Civil Engineers." There was a time when the meaning of the word "Civil Engineer" was so broad as to embrace every possible line of engineering work, and was used to distinguish from Military Engineering. During that time the Canadian Society of Civil Engineers could have been justly considered as truly representative of all its members no matter in what special branch of engineering they were engaged. There was also a time when the mere interchange of technical knowledge among the members of a technical society was of sufficient interest to sustain an organization in an active condition. But times have changed. The Engineering profession has broadened out to an enormous extent; numerous new branches and activities in the profession have been created. Civil Engineering itself has become narrowed down to mean and include only certain, definite and limited lines of engineering undertakings. Other lines of engineering, equally as important, have become developed and justly demanded independent recognition and designations as major branches of engineering, such as Mechanical, Electrical, Mining and Chemical. It was no longer possible to include all members of the profession under the title of Civil Engineering, and it became imperative to change the name of the society so as to make it unmistakably representative of the entire profession. It was thus that the name of the Engineering Institute of Canada came into being.

Likewise, the activities of the Canadian Society of Civil Engineers, which were limited chiefly to interchange of technical knowledge among its members, were beginning to lose their attraction in the eyes of the new members, particularly the younger men. With the limited and narrow activities it was no longer possible to create sufficient enthusiasm to warrant the growth and expansion which such an organization requires in order to live. Changed conditions brought about by economic developments in recent years made it quite evident that above all the engineer is human, and in addition to the technical problems that he meets with in his daily work he also has other problems, in common with the members of all other professions and classes in the community, which should receive his earnest attention. It became apparent that if the Canadian Society of Civil Engineers was destined to become the leading organization of the engineering profession in Canada it must assist its members in the solution of their human problems as well as their technical problems, even if to do so it might have to abandon some of its old traditions and recognized policies.

It is generally recognized, I believe, that the re-organization of the Canadian Society of Civil Engineers into the Engineering Institute of Canada paved the way for broader activities in new spheres which will ultimately result in greater usefulness of the Institute to the individual members, and of the members of the Institute to the general public. Our organization as founded and in existence to-day is, it seems to me, bound to be successful, because its constitution is flexible enough to be capable of adjustment to the constantly changing conditions and requirements of its members.

**What is the objective of the Institute?** The answer is given in one word—Service. To justify its existence the Institute and all its activities must be dominated by the desire and the determination, backed up by the individual effort of every member, to be of service to the Nation and the community and to its own members.

In regard to the service which the members of the Engineering Institute of Canada can render to the general public, to their home community and to the Nation, the problems which Canada has to face in the immediate future are problems in the solution of which the engineer must play an important part. The influx of foreign population, which will be great, is bound to create a situation to deal with which will require the utmost wisdom.

We as engineers should see to it that we are not in danger of repeating the discreditable slum conditions prevailing in the Old World, conditions which are productive of disease and physical and moral deterioration. The Engineering profession should be able to do more than any other to advise measures to deal with this problem. It means improved methods of economical house construction. It means good roads at moderate cost. It means a scientific planning of streets and parks, and it means a rapid transportation system with moderate fares to relieve the congested districts. The incoming immigrant must be Canadianized, and in what better way can this be accomplished than by showing him that the new conditions in which he will live in Canada are infinitely better than those he left behind. The trained intelligence of the engineer will always be a factor in the solving of this most difficult question.

The second way in which members of the Institute can be of service to the Nation is in regard to the present industrial situation. One of the important factors of the present-day industrial stagnation is the high cost of construction, and yet there has been very little organized effort on the part of engineers to promote construction activity. There is a growing feeling, however, that engineers should become leaders in political economy and a strong conviction that the time is opportune for 'engineering organization to take the leadership in persuading the public to support every truly economic plan for public works.

The assuming of such a leadership by engineers would be well-timed because the recent war has taught the public much about the importance of engineering, and because the present business depression makes it generally evident that a revival of construction activity will assist in accelerating the wheels of industry.

In a recent article in the "Engineering and Contracting" it was pointed out that the construction industry is one of the five greatest industries in the country. Construction is divisable into three classes—private, public and semi-public. Approximately 30 per cent. of the whole is private and the remaining 70 per cent. is public or semi-public.

In order to stimulate construction activity there should therefore be concerted effort to convince the public that when times are hard public works should be started on a large scale. It is false to argue that when private companies are reducing expenditure for construction, Governments and municipalities should do likewise. If engineering societies would take the lead they would find it easy to secure the co-operation of various public bodies and the daily papers, in spreading propaganda favorable to a programme of extensive public works.

In a special bulletin recently issued by the United States Chamber of Commerce the statement is made that one-fourth of their national wealth is represented by the structures and projects built by the construction industry. The current importance of the industry is indicated by the fact that one-fourth of the persons engaged in manufacture are working on material and products that the constructor will use, and it is for the engineer and architect to plan how this huge amount of material is to enter into the actual construction. The majority of engineers, I am afraid, do not fully appreciate their value to the community.

Herbert Hoover, addressing the American Engineering Council on taking up the slack in industry, referred to the thought and influence of their 200,000 professional engineers, and continued: "This great body of men in administrative and technical service penetrates every industrial avenue and thus possesses a unique understanding of many of our intricate economic problems and an influence in their solution not equalled by any other part of the community. Wanting nothing from the public either individually or as a group, they are indeed in a position to render disinterested service."

And thirdly, in connection with the solution of the huge problem of transportation, what possibilities there are for the trained mind of the engineer to visualize the future greatness of our country and to assist in laying the foundations for a transportation system comprising a network of highways, railways and waterways which will adequately serve the growing needs of a growing nation. The development of the Ontario Government's system of provincial highways; the Federal Government's system of Canadian National Railways of 28,000 miles, the greatest mileage of any railway system in the World; the Canadian Pacific Railway, second only to the Canadian National in mileage; the hydro-electric power systems, whose output will some day help to solve the fuel problem on our railroads; and the proposal now under consideration to improve the St. Lawrence waterway to accommodate ocean-going boats, open up a field for service unprecedented in the history of the profession in Canada.

May I be permitted in passing to refer briefly to one of these great projects, namely, the St. Lawrence waterway project, which, it seems to me, is one of the biggest and most far-reaching questions before our Federal Government to-day.

Early in 1920, Canadian and United States Government Engineers were requested by their respective Governments to report to the International Joint Commission on the further improvement of the St. Lawrence River from Montreal to Lake Ontario to make it navigable for deep-draught vessels of either the lake or ocean-going type, and to obtain the greatest beneficial use from these waters. While the Engineers' report was being prepared the Commission, consisting of three members appointed by the Canadian Government and three members by the United States Government, held sittings in many Canadian and American cities to take evidence for and against this project.

The Engineers reported in June, 1921, and their report is a favorable one. The total distance from Ogdensburg to Montreal is 182 miles, and the difference in elevation between these two points is 224 feet. By the construction of only 27 miles of canals and nine locks the whole water-course is made navigable for deep-draught vessels, and 1,464,000 horse-power of electric energy is developed by damming the Long Sault rapids at Cornwall and Ogden Island. The total cost of the scheme as reported upon is $252,000,000. I have briefly referred to this great project because of the immensity of the undertaking; also because transportation charges are a big factor in the present high cost of everything, and the advocates of this scheme believe that it will go a long way towards reducing these charges.

I have so far referred to the services which the members of the engineering profession can render to the Nation and the community. Let us now consider some of the advantages that will accure to the individual members as a result of our being united in one nation-wide organization.

The Engineering Institute offers, through the weekly meetings, an opportunity for the acquirement and interchange of professional and general knowledge among its members. When the University training is finished we enter the larger and more bitter school of experience, and there we learn to value the opinions and assistance made possible through the chance to intermingle with fellow-members of our profession. Technical knowledge can be acquired by close application to study; next comes the ability to put your technical knowledge to a practical use. But success is still not assured without the personal relation, or business connection. Cultivate the acquaintanceship of the influential men in your community. Above all things convince them of your integrity and intensity of purpose. The man who is always trying ultimately gets somewhere. We believe that these meetings of the Institute should be a means also of acquiring much valuable information of a general nature. With that object in view this year's programme includes such subjects as Town Planning, Contract Law, Municipal Financing, Public Health and other matters of public interest.

The Engineering Institute can also be of service by promoting the professional interests of its members, first by securing proper recognition for the profession

As a result of concerted effort, engineers have already succeeded in obtaining special legislation in all but three Provinces of the Dominion. This special legislation is primarily intended to serve one main purpose, namely, to protect both the public and the profession from the results of the practise of engineering by those not qualified. If this principle is rigidly applied to any engineering legislation that may be framed it will be found that the engineer has received his full measure of protection. All that Engineers as a class are entitled to is some effective means of protecting their professional reputation and prestige. Legislation has been framed to meet this end, and so framed as to be for, and not at the expense of, the public weal. Anything beyond this may be defined as class legislation, which in the final analysis does not protect, but stigmatizes and would ultimately force the engineer into the position of having to protect his legislation instead of having his legislation protect him.

In the Province of Ontario last session the Advisory Conference Committee, the Ontario Provincial Division and the various Branches expended a great deal of time and effort on an Engineers' Bill for this Province. Unfortunately it was submitted to the Government too late to be considered by the Private Bills

Committee and had to be referred to a special committee, which did not report before the close of the session. There did not seem to be any particular opposition to the Bill itself, and I believe we are justified in believing that we will attain our objective during this session of the Legislature, provided every member of the Institute in this Province uses every means in his power to further the interests of the Bill.

The Institute can further serve its members by securing proper remuneration for engineering services.

A great deal has been said and written on this important topic during the past two years, and perhaps no single subject has received as much attention and consideration from the various Branches as the question of classification of and compensation for engineers. The Toronto Branch was the first, I believe, to submit a report on this matter. The report of the Special Committee was approved by the Branch and submitted to Headquarters, and since that time a number of other Branches have forwarded similar reports. Headquarters then decided, through their Committee on Policy, that it was a matter which they should take up. As a result of this action a Committee on Remuneration was appointed by the Council to study the whole question, using as a base the reports of the various Branches and having access to the schedule prepared by the Engineering Council of New York. Their findings have not been made public.

There is no doubt but that the problem of adequate remuneration is a difficult and complex one. The subject is closely allied with the whole question of economics, which in turn is an important phase of the problem of production. The production of the engineer is evident in constructing means of transportation, whether by rail or water, in the development of an irrigation project, in the inventing and perfecting of machinery, in the generation and transmission of electrical energy, in obtaining from the earth its store of mineral wealth, or in the chemical analysis of the metals and kindred building products. In every one of these processes the main objective is to obtain an adequate return on the money invested, and the engineer is depended upon to produce the desired result, and every detail in his daily work is thought out from the standpoint of economics. Probably a foreman with no technical training could design a steel bridge that would carry a train. The qualified engineer gets the same results, but uses ten or twenty per cent. less metal. The saving is not only to his principals, but to the Nation in the conservation of natural resources. This principle of economics enters into the daily life of the engineer more than into that of any other profession, and assuming the above statements to be correct, who is better qualified to deal with the big economic problems than the engineer?

At the present time the entire World is undergoing a period of economic readjustment, which has thrown everything out of balance. Uncertainty as to what the future may bring is affecting business relations. The wheels of industry are certainly not running smoothly, and not only individuals but whole nations are suffering as the result of adverse trade conditions. In such a chaotic condition of affairs one naturally asks the question what service could engineers render to ameliorate these conditions, to assist in speeding up the readjustment and to clear away some of the clouds of uncertainty that are dimming our vision. How tremendously worth while it would be if the engineering profession would grapple with and assist in solving this acute problem, and having done so, who would deny us a remuneration comparable with the service rendered? Let us place a higher estimate on our own value to the community, not only in our professional relations but in all matters of community interest, and employers of engineers as well as the public will be quick to accept us at our own valuation.

The Engineering Institute can also be of service to its individual members by maintaining a high standard of ethics in the profession. Our standing Committee on Ethics presented two reports to the Branch last year on a Code of Ethics for Engineers. The Committee will report further in the near future. Other engineering organizations are also attempting to write new codes of ethics. These efforts are, it would seem, a hopeful sign of progress, not necessarily because they will produce a good code of ethics, but because they will increase the thought which engineers will devote to their relation to fellow-engineers and to the public.

It is inevitable that each one of these engineers by virtue of such reflection will become more keenly conscious of the special trust with which he is charged by reason of his profession's place in community existence. Therefore, even without the production of an accepted code, co-operative study of the subject will yield benefits to the public as well as to the profession by quickening the professional conscience and recognition of the duty of service.

In addition to this, it is broadly true that any movement which aims to re-formulate basic principles of just conduct is of very special value at the present time, since the engineers' objective attitude is most essential to the World's reconstruction.

There is another thought that occurs to me in connection with this question of ethics, particularly in regard to our relation to the public. Why do engineers frequently harbor personal feelings against those with whom they disagree on technical matters? Engineers are perhaps more sensitive regarding disagreements of opinion than other classes, because they are accustomed to dealing with facts and with immutable natural laws, They feel instinctively that there is about everything a definite position which must be right; what differs from it is wrong. There is, of course, a right and wrong to every question. but the difficulty is that most problems are so complex that we are unable, with absolute correctness, to appraise the value of each factor. Some problems are subject to exact mathematical determination, but by far the greater number of them call for the application of the standards of individual experience, in other words, of judgment.

We need, therefore, to realize that our opponent in the discussion may have as good ground as we for his conclusions and to derive from that reflection an attitude of tolerance, and respect, for opposing views. Above all, we need to regard problems as objective and to refrain, unless the grounds are very clear, from imputing motives to our opponents. Let there be fair, even strenuous, discussion, but let the personal relations be in nowise disturbed.

The Institute can further be of service to its members by seeing that due publicity is given to the work of the profession.

The ordinary means of obtaining publicity for the engineering profession are fairly numerous. The outstanding requirement under this head is for engineers as a class to participate in the affairs of Federal and Provincial Government. This contention is so fundamentally sound and so generally recognized that it is not necessary to enlarge upon it. It is true beyond argument that the recognition of the engineer as related to national affairs cannot be advanced or conserved unless the engineers themselves exercise active governmental functions in connection with the laws relating to, or incidentally affecting, the profession.

Among other channels of publicity may be mentioned the active participation of engineers in all general problems affecting the life of the community, and in developing such problems into specific schemes for Government ratification and administration. Conditions governing publicity in the broad sense demand that engineers identify themselves with all benificent movements and projects, particularly those which have a wide public appeal.

## Why Should Undergraduates Become Associated With the E. I. C.?

The last phase of this subject to which I wish to refer briefly is, "Why should undergraduates in engineering become associated with the Engineering Institute of Canada?" In every city where there is a University there is a branch of the Institute, of which every prominent engineer in the community is a member. Student membership in the Institute and attendance at the weekly meetings therefore provides a possibility of meeting the older members of the profession. The extent to which this possibility may become a probability depends on your own initiative, and as previously stated in these remarks, do not forget that when a man has reached the age of 35 or 40 the best asset he can have, in addition to his University training, is a business connection, or if that is not possible, a speaking acquaintanceship, some kind of a personal relation, with the influential men in the community, whether they be inside or outside his own profession.

In order to accomplish this you must cultivate the art of being a good mixer among your fellow-undergraduates. Do not spend all your time in the lecture-room and your study. They should have a proper proportion of your time in order to secure that training which is so essential in after years; but there should be time also for the non-technical activities of University life, and it is in the following up of these that you will acquire the rudiments in that art of mixing which in later years you will find almost as invaluable as your college training.

Then again, by becoming associated with the Institute you are giving your help to building up a nation-wide all-Canadian Engineering Society. The larger the membership the more influence the organization will have in furthering the interests of the members at large and increasing its standing as a body representative of the profession. As an example, the strength of the organization both in members and in the personnel of its membership is an important factor to-day in our efforts to obtain protective legislation.

Attendance at the weekly meetings of the Institute provides the further opportunity of encouraging public speaking. In the discussions of the various papers which are presented everyone present, if he so chooses, has a chance to take part, and it is there possible to develop and improve the very valuable art of speaking in public under circumstances where you will have the advantage of criticism of the kind intended to help. It is generally recognized, and in the majority of cases, only too true, that as a class engineers are too retiring. In public meetings they listen to speakers discussing subjects with which they themselves are more familiar, but on account of their inability to express themselves through inexperience, are compelled to remain silent. This point cannot be urged too strongly on the members of your society, because it is absolutely essential if your members are going to take their proper place in the profession and assume the responsibilities incidental to it.

At these weekly meetings also you will hear discussed both engineering and general topics. They should be of value by keeping you in touch with the larger engineering projects under consideration or construction, and with allied subjects. A knowledge of public health, for example, or public finance are absolutely necessary in order that you may become not only good engineers, but also good citizens. The educational value of these meetings alone make them more than worth while.

### Achievements of Sir John Kennedy.

What appeals to me as one of the greatest inspirations one can get as an incentive for greater self-improvement is the reading of the wonderful achievements of outstanding men, and so I am going to conclude my remarks to-day with a brief reference to the life of Sir John Kennedy, one of the most eminent engineers of the last generation, who died recently.

Sir John Kennedy, the great engineer, who died on October 25th, full of years and honors, found the port of Montreal a shallow roadstead and a haphazard aggregation of primitive wharves, a few feet above the water level, when he in 1875 was appointed chief engineer to the Montreal Harbor Commission. The port was a thousand miles from ocean water, and one-fifth of this distance, separating Montreal from Quebec, was a narrow, tortuous and in places dangerous channel, only twenty feet in depth, limiting its navigation to river and lake craft and the smaller ocean-going steamers of the day. Added to this handicap was the fact that the river at Montreal contained strong and tricky currents, which increased the difficulties of entering and leaving the port, while each spring the harbor was exposed to the possibility of serious floods, which not only wrought damage to the wharves and other shipping facilities, but also at intervals covered wide expenses of the city's lower level, causing great inconvenience and loss to the city.

These were the conditions existing when Sir John, then plain Mr. Kennedy, came from the Great Western Railway to take over the task of making Montreal an ocean port which should prove not only third in importance in America, and rank high among the world's greatest harbors, but in some features set the lead for all others. Fated to lose his physical sight fifteen years prior to his death and before the monumental work which he planned was fully carried out, he possessed from the beginning to the end of his life that inner vision of genius which sees design and achievement as one. A practical visionary, he might be called. When he spoke of piers one thousand feet in length for Montreal the scornful jeered, yet to-day ocean liners and freighters from all the seven seas lie at these piers. He built a breakwater one and one-half miles in length, averted forever the menace of havoc by floods and moderated the influence of the currents. Sir John himself designed dredges of a new type to meet the demands made by the engineering and geological difficulties to be overcome both in the harbor and in the river channel to Quebec, which under his direction was deepened to twenty-seven feet and made as safe for navigation, allowing for the fallible human equation, as the traditional mill-pond.

Although only thirty-seven years old when he became chief engineer to the Montreal commission, Sir John was already known as a leader in his profession, and he had had wide experience in railways, mining, water works and other branches of engineering. His reputation continued to grow; he became recognized among his fellows as an authority upon engineering practice, and he was frequently called upon to advise upon large undertakings, both in and outside of Canada, by governmental, public, and corporation bodies. In his personal demeanor modest, approachable and kindly, sincerely religious and animated by a spirit of service, and taking a keen and cheerful interest in world affairs to the very end, despite his affliction, Sir John Kennedy was a type of the manhood which has helped to make Canada what it is, and of those whose work and influence will be impressed upon the generations to come.

## ORGANIZATION.

By Prof. E. A. Allcut.*

AN old lady, more distinguished for piety than for learning, once stated that she was always greatly comforted by "that blessed word Mesopotamia." During the World War, and in the financial chaos that accompanied the Great Peace, the "Mesopotamia" of the industrial world was "organization." This was the panacea for every ill, and the "open sesame" for all the caves of national prosperity. What was to be organized, who were to organize it, and the nature and scope of the proposed organization, were either left conveniently to the imagination, or else varied with the experts who proposed it.

In considering this question, therefore, it is advisable to first define the term "organization," and then to consider its application and limitations. The dictionary states that "organization" is "the state of being organized." This does not carry us very far, but "organize" is rendered "to supply with organs" or "to arrange," and in this form it is capable of direct application to the engineering industry.

Schemes of national recovery are inevitably dependent on production. But what is "production"? In the engineering world there is no such thing as production in the sense understood in agriculture, as there is no growth. In this case, therefore, production is simply another name for transformation of material from one form into another more useful one. For instance, iron ore is a source of national wealth solely on account of its potentialities. It is useless in its primary form, but when smelted, puddled, forged and machined, it becomes an article that can be used directly to increase the comfort of human life, speed of transport, or means of communication. For this increased comfort humanity is willing to pay, and therefore the value of the material is increased by suitable transformations. In other words, engineering "production" consists of the increased value arising from work done.

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But such an increase of value is useless unless it can be realized, and at this point the effect of competition comes into play. It is useless for an engineer to make an article to sell at $100, if his competitor can produce and sell an equally good article of the same kind for $80. In that case, the finished work will remain in his own stores, because the effect of the increase of value cannot be realized, and in due course the works will shut down, because money is continually going out to pay for raw material, wages, taxes, etc., and the income from sales effected is insufficient to meet the expenditure. His "production" therefore ceases to be a national asset, and his men are added to the ranks of the unemployed, to be an additional source of loss to the community.

The question next arises, "Why does one man require $100 when another can do the same work for $80?" In the case of different countries, or widely separated communities, differences in the rates of wages paid, or in the cost of transport, are large factors in determining prices. But where competitors are in the same district wages are usually standardized, and therefore do not enter into the question to any great extent, and cost of transport is obviously the same for both. The main differences are those of size and organization.

It is well known that articles made in large quantities can be manufactured at less expense than similar articles produced in small numbers, and thus the size of the business plays an important part in the economy of manufacture. A case in point is that of the automobile. If these were produced singly, they would be as rare and valuable as jewels, and only millionaires could afford to buy them. By making large quantities of similar machines, the cost of each machine is reduced to reasonable dimensions, and consequently the number of potential customers is greatly increased, providing the necessary market for the output of the factory. The principal differences between large and small works are those of arrangement, and therefore the whole question is narrowed down to one of organization.

This is an age of specialization. It has been proved repeatedly that if a man is doing the same kind of work continuously, he is able to perform that work more accurately, rapidly and economically than can a general practitioner. Therefore, instead of "Engineers," we now have "Civil, Mechanical, and Electrical Engineers," and subdivisions of these professions as the principle is further extended.

In the workshop, too, the old type of mechanic has been superseded by specialists in the form of Turners, Fitters, Grinders, etc., each restricting his attention to one kind of machine or process. It is quite a common experience for even a skilled mechanic, given a new machine or fresh process, to increase his output 500 or 1,000 per cent. after a few months' experience. Still more is this the case with the unskilled or semi-skilled operatives that are now employed on many special machines, and in determining piece work rates on a new job, rate fixers have to make allowance for the speeding up that is likely to take place eventually, and as the operator generally objects, disputes arising from this cause are not infrequent.

Obviously, as the output of a machine or man increases, the cost of the article produced decreases, and therefore machining operations are now planned to make the most of this fact. Machines are set up with special jigs and tools for performing one set of operations only, and if further work of a similar nature is required, the unfinished article is passed on to another machine of the same type, set up in a different way for the remaining operations. In this way time is saved by avoiding the delay which occurs when the setting or arrangement of a machine is changed for completing a series of processes. This involves the provision of more machines for doing the same kind of work, but each machine carries a greater load and so becomes a more economical unit.

The erection of machinery is facilitated in a similar way. Formerly the machined components were delivered to an erector or gang of erectors, and they undertook the fitting together of the machine from start to finish. These men had to be familiar with a great number of processes, and a good deal of experience was necessary before a man was deemed sufficiently skilled to be entrusted with the responsibility of such work. The natural consequence was that the men, when trained, were very valuable to the firm, and frequently stayed for many years in the same shop. In numerous cases, special jobs descended from father to son over several generations. With increasing specialization and a decrease in the amount of skill and experience required by mechanics, this state of affairs has largely ceased to exist. Machining operations are more accurately performed, and therefore the amount of hand work required is reduced. Machines and engines are now erected in sections, a definite part of the shop being allocated for the fitting together of each section, and then the various fitted components are delivered to the final erectors for assembly. The fitters thus become more expert at their own job, but their general adaptability is greatly diminished.

By sectionalizing and specializing the work in this way, its final cost is reduced, but the difficulties of shop transport are increased. When work is put through in small quantities, it is transported from machine to machine, and from shop to shop by a general corps of laborers, working under the instructions of the shop foreman or superintendent. With specialized processes, the number of transportations increases in proportion to the number of processes, and therefore the transportation system must be carefully organized to avoid congestion and loss of time, and also the machines themselves must be arranged to give a minimum distance of transport from one series of operations to the succeeding ones, and as far as possible, to ensure a continuous flow of material from one end of the shop to the other. The machines should therefore be put down in the order of the various operations, so that new material enters at one end of the section and finished articles leave at the other end.

In shops dealing with large quantities of material, this result is sometimes produced by the use of belts or conveyors, which transport the materials or partly erected machines, from one operation to the next, until manufacture or erection is completed.

These methods involve the existence of organizing departments for the purpose of controlling and supervising each detail. For instance, the efficiency or planning department must arrange the works and the various shops in the first place, to reduce transport and operating costs to a minimum, and they must see that the most economical arrangements are made to deal with any alterations of plant or machinery that may be necessitated by improvements in the design of the finished product or in methods of manufacture.

The production and progress departments must see that the machines and erectors are kept continuously supplied with material, and that a minimum of stock is kept in the various stores, consistent with continuity of supply and allowing for possible production difficulties.

Such organization, therefore, is not an unmixed saving, as extra expenditure is incurred in providing new and special machinery, and in running the organization itself. This additional expense must be debited against the saving resulting from the improved manufacturing arrangements provided.

It is evident also, that when machinery and equipment are specially laid down for doing definite work in a certain order, the design of the final product must be standardized beforehand, as the cost and dislocation resulting from improvements in the form of the article, is likely to be considerable.

The organization must therefore be as elastic as possible, consistent with economy of manufacture, to guard against such rigidity, and the continued production of an inferior article on account of the cost involved in proposed alterations.

In these instances, it is necessary to handle large quantities of material in order to keep the machines and men fully employed, and this implies a large capital expenditure and consequently a big output to provide sufficient revenue for running the works.

The decisive factor, therefore, is the market available for the finished product, as, if the whole output cannot be sold, the works must eventually stop, and thus, the organization or arrangement of any works, must depend upon the quantity of similar articles that can be made and disposed of in a given time.

Although scientific control and arrangement of factories are very attractive propositions in theory, particularly for young engineers, the extent to which the various schemes, so plausibly advertised, can be carried in practice, varies considerably in different classes of work.

It should be clearly understood that the management must run the organization, and not the organization, the mangement. Too many firms have been "organized to death," and the success of any manager is determined by the extent to which he can build up his organization without overburdening his works by excessive overhead charges.

It is quite an easy matter to spend a dollar in order to save ten cents, but the final test of any system is the amount of money saved by it, **after deducting the cost of the system itself.** When it becomes a burden instead of a saving, it is better to recast the organization on a more sensible and economical basis, and not until then does the system become truly "scientific."

## AMERICAN ARCHITECTURE.*

By John M. Lyle.

I AM going to try to give you some idea of the great American Renaissance in Architecture which has been in full swing now for the past fifty years. I want also to tell you something of the architects themselves, many of whom I am fortunate in knowing personally.

You must bear in mind, however, that the opinions I shall express to you are purely personal and not in any sense dogmatic, for it is a great mistake to be too dogmatic in matters of taste. One must always remember that taste is an ever-changing factor, and that no two persons will agree as to what constitutes good and bad taste. What we like today we may abhor in ten years' time.

Taste and charm in architecture are qualities that are difficult to define, and must be felt to a large degree. They are, however, noticeable qualities in the work of all great architects.

I should like to urge on you all the great importance of cultivating the æsthetic side of your education; much of this you must get for yourself entirely outside of your practical and technical studies in the University or in the office.

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*Synopsis of an address delivered before the Architectural Club, March 14th, 1922.

This is doubly important for the Canadian student, because he has not the advantage of the European student in being able to see masterpieces of architecture, painting and sculpture staring him in the face at every turn.

How, you ask, is he going to form a standard of taste without going abroad?

My advice to him is, that given a certain amount of natural liking for the beautiful, he can, by study of the most interesting and fascinating kind, acquire a standard of taste that will be invaluable to him in his future career, and moreover he can continue his studies along these lines until he is ready for the grave.

He must learn of painting and painters, of sculpture and sculptors, of stained glass, of tapestries, of furniture of the different periods, of china, of silver, in short, of all objets d'art. It is a life study, but an entrancing one. He must read books on these subjects and books on the lives of the men who worked the masterpieces of the past.

He should not fail to go to the picture galleries, the Museum here should be an open book to him—and in this connection I should like to congratulate Professor Currelly on the steps he is taking to develop the art side of the Royal Ontario Museum. We, as architects, do not wish a natural history museum or a curio shop, but an art museum.

It is a well known fact that one often lives and works in the midst of some great political or artistic movement, without really appreciating just what is going on.

That the United States has been going through a great renaissance in architecture during the past fifty years, is just now being recognized abroad. In my opinion, the work that has been turned out by the American architects during this period, far outshines that of any other country during the same time.

Rupert Brooke, the English poet, said some ten years ago that he placed among America's five greatest achievements her modern architecture. A writer in that conservative and very excellent English publication—Country Life—remarks that "Anyone who has visited America recently will realize that if magnificent modern architecture ten years ago was one of the five finest things she has produced, this architecture has now probably reached the first place."

We now find English architectural students coming over to McKim, Mead & White's office for summer office experience.

What are the outstanding features of American architecture?

1. Its scholarship.
2. Its solidity and simplicity.
3. Its restraint.
4. Its execution.
5. Its handling of monumental work on a big scale.

Dealing with the first—its scholarship—there is no question but that the training of the American architect has had a great deal to do with the success that has attended his efforts in solving the various problems that have come before him. Following the French, rather than the English methods of architectural education, he has learned how to study, how to attack a problem, and the great success of the American designer in solving problems and of using different styles, is largely due to his education.

While it is true that they have had unequalled opportunities, it must not be forgotten that the designers have risen to them and are primarily responsible for American architecture.

Very many of the foremost American architects are graduates of American universities, and have supplemented their American training by a European one, principally at the Ecole des Beaux Arts. I cannot remember a single American who was in France at the same time I was, who was not a graduate of Yale, Harvard, Princeton, Columbia, or some other university. These men spent anywhere from three to six years at the Beaux Arts. It was always a source of wonder to me how many of them could speak two or three languages. All were deeply interested in architecture and had their weather eye always open for a bargain in the antiques.

Second—Its solidity and simplicity. These are undoubtedly two marked qualities noticeable in American architecture. If you will pay attention to the slides which I am going to show you, I think you will agree that this statement is correct.

The American architect seems to have caught something of Sir Christopher Wren's spirit, who believed that architecture should have the attribute of the eternal and that the "little knacks" should be avoided.

The buildings seem to be made up of a few parts rather than of an infinite number of small parts, or in other words, they are well studied, well composed, with a consolidation of ornament and a simple treatment of wall surface, depending on their scale and proportion for much of their beauty.

Third—The restraint, noticeable in the best American work, is very patent when you compare it with corresponding English, French or Italian work. A building may be well proportioned and well composed as to mass, but if it is plastered indiscriminately with ornament, then the abuse of this legitimate device defeats its own object, even if the ornament be good in itself.

Fourth—The execution of the American work is of a very high order. I do not think that any country can show such a high standard of excellence as that of McKim, Mead & White, and this is also true of the work of many other firms.

I would give special credit to McKim, Mead & White for this reason, that they have always insisted on the highest possible standard in their stone work, brick, plaster, wood and iron work; picking their contractors, who, it is well known, always figured high on their jobs, for they knew that none but the best work would be accepted.

Their influence has been one of the great factors in establishing a high standard of workmanship, ably supported by the younger men of today.

The great works that have been under way in the United States have naturally attracted many of the pick of the world's craftsmen. I know of several jobs where special workmen were brought from England, France and Italy for particular work.

Five—There are only two groups of architects who have attained a marked degree of eminence in the handling of monumental problems—they are the French and the American; the Italians have never grasped the fundamental idea in monumental work, which is so closely related to planning. I am not referring so much now to monumental buildings as to large developments involving group planning.

The Italian, of course, has given us some of the greatest individual monumental architecture of all time, but he rarely had that sense of placing a building or buildings so that they would count—at the head of an avenue, or to form the sides of a square. True, that Bernini's Colonnade, and Michael Angelo's wonderful Conservatore Group are masterpieces, but they are the exception. Many of the greatest buildings in Italy are lost by reason of their setting.

In the designing and handling of individual buildings of a public or monumental character, the American architect has shown great skill. True that one can often trace the influence or source of inspiration, whether Italian, French, English or Spanish, of much of the work; nevertheless, there is much personal feeling, resulting in an architecture which is distinctly American. They have realized that the bizarre and picturesque touch which may be so delightful in a small country house, is an absurdity on a bank or court house. They seem to have had the job in mind rather than the desire to use some particular piece of ornament or pediment to the detriment of the design.

To quote from T. B. Bennett in "The Studio": "Great architecture has in all periods seized upon the requirements of its client and by natural expression has transformed them into works of art. It has always frankly accepted the limitations of site, material, cost of construction, and used them as a means to an end."

"The ability of the American designer to seize upon and emphasize the essentials of his problem is noteworthy., a chapel, a bank, a library, or an office building, all indicate clearly their special purpose."

The essentials of American architecture can be defined in a few words, as the work of men of taste who have added knowledge to their ability.

# ARTISTIC DESIGN OF BRIDGES*

By Charles Evan Fowler, Chief Engineer, Detroit-Windsor Bridge; Consulting Engineer.

THE use of such a title for this brief article, as is usual in similar discussions, "The Architecture of Bridges," would seem to the writer to point to a misconception of the real problem. There is as yet no architecture of bridges and it is doubtful if there ever will be any system of hard and fast rules to govern their artistic design.

There are, however, certain fundamental principles and certain elements of design which must be observed, if we are to arrive at a pleasing ensemble for any particular structure. The problem is much more simple if we are designing a stone arch bridge, or one of concrete, or one of reinforced concrete, than is the case when designing a steel span or series of such spans. However, there are certain basic principles that apply to any and every type of bridge.

## Artistic Essentials.

Simplicity, Harmony, Symmetry and Proportion must be regarded in any design that would have any pretentions to beauty or artistic effect. They are the fundamentals of true architecture or artistic design, no matter what the structure may be to which thought is to be applied in its design.

"Then prove we now with best endeavor,
  What to our efforts yet may spring,
He justly is despised who never
  Did thought to aid his labors bring.
For this is art's true indication,
  When skill is minister to thought,
When types which are the mind's creation,
  The hand to perfect form hath wrought."

Simplicity means first a truth-telling structure, no subterfuges about the lines of stress, no covering of a concrete structure with a stone facing, no frivolous or inappropriate details, but a strict adherence to the necessary features, whether they are to carry the loads or to ornament the bridge.

Harmony is essential to a pleasing or artistic design, for without it the structure would be distasteful. Harmony not only as between substructure and the superstructure; between the various spans; between the spans and approaches; between the utilitarian features and the ornamental details, but with the surroundings as well.

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*Address delivered before the Civil Club, Wednesday, March 22nd, 1922.

Symmetry may or may not be essential to a pleasing design, although it usually is necessary if a truly artistic structure is to result. Where the bridge has great length, unsymmetrical features are not so noticeable as in a shorter one, which may all be seen at a glance. As is often true in a landscape, balance must often be secured by including an unsymmetrical feature. That is, wherein one portion of a structure, a draw span or other unbalanced feature must be included that will destroy the symmetry, something must be introduced in another portion that will restore the balance, although symmetry does not result.

Proportion is necessary, that the three preceding principles may be realized, and usually, but not always, when the economical proportions have been determined, they are pleasing. However, in many cases modifications must be made to reach the point where economy and beauty can both be satisfied. Proportion of the details employed for ornamentation is quite another thing, and to be harmonious they must also be properly proportioned.

Examples may be seen in almost every structure of the proper application of some of these principles, but more often do we find most of them flagrantly violated. The remark made by C. Shaler Smith. the dean of American bridge engineers, to one of his assistants—"Most bridges are examples of what not to do"—must be remembered by anyone who wishes to attain to high rank in his profession. It is to be feared that in most cases we feel that, "in the long run, the average sense of the many is better for the many than the best sense of any one man." There is a right and a wrong; most engineers attain neither, in the hope they are right and the fear they are wrong.

## Pleasing Ensemble Vital.

We need not care whether a detail is Byzantine, Greek, Roman, Gothic, or Renaissance if it is of the proper proportion, harmonizes with the other details, with the structure, and helps in forming an entirely pleasing ensemble. The Gothic arch was Persian before it was Gothic. Our structure may be similar to a work of architecture, in that it is neo-classic, but who would say that for this reason the Rathhaus of Cologne, or the Hotel de Ville in Antwerp, are not good pieces of art?

The diagonals or latticing in a bridge are sometimes unpleasing, and at other times in some other structure, not unpleasing. They probably originated with the savage, who used vines or fibre to form diagonals for his primitive structures. The farmer of today still uses ropes or wire for similar purposes, but as yet diagonal bridge members, nor yet the garden trellis, have been accorded a niche among architectural styles. The engineer, for some scores of years, has calculated his diagonals, and used them in his design because he believed they were necessary, no matter how incongruous they appeared. Now we know how to provide for secondary stresses and can often omit the diagonals whenever a more pleasing structure will result.

### Ornamentation

The curved lines of the suspension bridge and of the arch are inherently beautified, and simplicity is best illustrated in its pleasantest features in bridges of this type with no decorations or embellishments of any kind. However, we must not overlook the fact that even a chaste design may be much improved in appearance by the use or addition of appropriate and harmonious details or decorations. The suspension bridge seems sadly designed where the towers are not properly completed by a parapet or attic storey for those of stone, and perhaps crestings for those of steel. The arch is made more beautiful by molded work in the arch ring, by the use of appropriate medallions at the key stone, by the careful embellishment of the spandrels or spandrel arches, and lastly by the use of well designed and ornamented parapets and parapet railings.

Harmony is best exhibited where no part of a structure or of its decorations seem to be extraneous, and where the structure harmonizes with its surroundings. This latter feature is illustrated by the harmony of the battlemented towers of the Conway suspension bridge and the Conway tubular bridge, with Conway castle; by the harmony of the medieval towers of the London Tower Bridge with the Tower of London; and by the harmony of the stone towers of the old Brooklyn bridge with the high buildings of New York City, although this is but a happy accident, as the buildings were the later development.

### Symmetry

Symmetry in its simplest form is where one-half of the structure is exactly like the other half, where one approach is like the one at the other end of the bridge. That is where the structure is perfectly balanced in the simplest manner. The most pleasing design is where the centre of the bridge is at the centre of the middle span, or it may be stated as a fundamental principle that an artistic bridge must have an unequal number of spans—one, three, five, or seven in number; but beyond seven spans the eye does not so readily grasp the whole and seek for an opening instead of a pier at the centre. Likewise the spandrel arches of an arch bridge must be three, five, or seven in each half of the span, or where they extend across the key stone, an unequal number for the whole span.

Proportion is most nearly reached when the whole structure is most pleasing to the trained eye, and the truth most closely adhered to in every part of the structure and in every detail. The use of too great a sag in a suspension bridge, or of too great a rise in an arch bridge dwarfs the apparent length of such a span. That is, too great for appearance, even if not too great for economy.

### Careful Study Needed.

We must remember that there is nothing really in common between the architecture of buildings and the artistic design of bridges. The lack of any attempt at artistic design in the Williamsburg suspension bridge is deplorable; the failure to complete the towers of the Brooklyn Bridge is deplorable; the attempt at an artistic design for the Manhattan bridge produced a structure which is only not unpleasing; but in the Hell Gate arch we have a structure which is of great simplicity, of real harmony, of true symmetry, and perfect in proportion. It is not often given to man or to the engineer, to attain nearly to perfection, seldom more than once; but by careful study and thought, we can obviate very many flagrant violations of the artistic in the design of our bridge structures.

"Chisel in hand stood a sculptor boy,
With his marble block before him,
And his face lit up with a smile of joy
As an angel dream passed o'er him.

Sculptors of life are we as we stand,
With our lives uncarved before us;
Waiting the hour when at God's command,
Our life dream passes o'er us.

If we carve it then on the yielding stone,
With marks of deep incision,
Its heavenly beauty shall be our own,
Our lives that angel vision."

# THE SCHOOL OF ENGINEERING RESEARCH.

By Maitland C. Boswell, Assoc. Prof. of Organic Chemistry, Secretary.

THE School of Engineering Research of the Faculty of Applied Science and Engineering of the University of Toronto was established in the spring of 1917, upon the recommendation of the late Dean Ellis.

It is under the direct supervision of a committee of management composed of fifteen members of the faculty council. To this committee is entrusted the selection of researches to be undertaken, from among those proposed by members of the staff, and the disposition of funds for conducting them.

The School was organized chiefly for the training of graduates in the methods of research, and for the carrying out of investigations. These latter may be problems relating to specific industries or raw materials and having a specific end in view, or they may be general problems having to do with fundamental principles.

A number of research assistants are appointed annually in the various departments of the faculty to carry on the work of research, under the direction of members of the staff. The facilities of the School are also open to other graduates, who may wish, either to obtain more experience in research, or to carry on investigations arising out of their own work since graduation.

A modest request for funds for the salaries of research assistants, and for the purchase of apparatus and supplies necessary for several specified investigations, having met with an encouraging response from the President and the Board of Governors of the University, the first research work, carried out under the auspices of the School, commenced at the opening of the session, 1917-18.

The success of the School at the outset was somewhat greater than usually attends a research movement in the year of its organization. Although papers containing the results of investigations constitute only one means by which the success of a research movement may be estimated, yet this is an important criterion of its growth. Bulletin No. 1, with fourteen papers, containing the results of investigations in six departments of the faculty, appeared in the autumn of 1919, and was very favorably commented upon by numerous engineers, investigators, and scientific and educational bodies, among whom it was given a wide circulation. The establishing of the School was justified, and those actively engaged in its work were encouraged to still further expand its activities. Further researches were undertaken, requiring a greater number of research assistants, and more apparatus, the increased expenditures being generously met by larger appropriations by the Board of Governors. Bulletin No. 2, containing seventeen papers, has just appeared, and will be followed during the coming summer by Bulletin No. 3. The very favorable reviews of the papers of Bulletin No. 2, which have already appeared in the scientific journals, as well as the increasing number of requests for papers and bulletins, are very encouraging indications of the steady progress of the School. So great was this demand for separate papers from engineers and investigators in many parts of the world, that the editorial committee decided to publish subsequent bulletins in sections, each section containing a paper or group of papers dealing with a single problem or group of related problems, the main bulletin consisting of several of these sections bound together in a single volume.

However, it is not in the publication of papers alone that the effects of a university research movement are felt. Of equal importance is its influence upon the undergraduate. Contact with a larger number of graduate students and members of the staff, who are carrying on research work, will more quickly develop the desirable point of view of the investigator, who reads the current literature of his science, and the original sources of information, rather than text books, which often have a tone of finality, and thus tend to leave the impression of science as a finished product, instead of as an organism undergoing constant change and growth. Thus, the undergraduate will be induced to develop his knowledge of the principles and laboratory technique of his science, so that he also may play a part, either in extending the bounds of knowledge, or in assisting in its applications to industry. The importance of this reaction of the School of Engineering Research upon the undergraduate, which will be more and more apparent as the School develops, can scarcely be overestimated. It is just this investigating quality which characterizes a university, and distinguishes it from a high school. A university is not a hopper through which huge masses of predigested facts are poured into students' heads.

This research movement has had a very encouraging and promising beginning. It has met with a considerably greater measure of success than is usual with new research organizations. That it may continue to grow, until it comes to occupy a position in the life of the university and the state, comparable with that attained by the long established and justly celebrated laboratories of older countries, should be the earnest desire of all the students, graduates, staff and friends of this faculty.

March 9th, 1922.

# SPECIAL WATER POWER LECTURES.

(Delivered Feb. 27th to March 6th, 1922).

By Professor R. W. Angus.

IN order to supplement in an effective way the courses in water power development which have been a part of the curriculum in engineering in the University of Toronto for many years, arrangements were made this session for a short series of lectures to be given by five prominent Canadian and American hydraulic engineers. The importance of developing our water powers has long been recognized and the hydraulic courses have always been shaped with this problem in view, and also with an idea of training engineers for water supply and irrigation.

After consideration it was thought best to deal with the water power development only, because sufficient time was not available without making the course much longer than was advisable at the present time of year.

In arranging the course, Professor Angus, head of the Department of Mechanical Engineering, under which the hydraulic work is done, invited five very prominent men who have become recognized authorities in a special field of the work, each of whom dealt with a different phase of it, so that in a brief way the whole problem of water power development was viewed from different angles and each detail received consideration. The speakers might all have been selected from graduates of the University of Toronto, amongst whom are many prominent hydraulic engineers, but the viewpoint of graduates from other Universities who have devoted themselves to this class of work was desired, and therefore, of the five speakers, only three were Toronto graduates.

From the outset the course was designed to be of particular value to advanced students and to practising engineers, so that the lectures were technical, rather than descriptive, and were of special interest to Fourth year men, but were also enjoyed by large numbers from the Third year as well.

Although the lectures chanced to come on the same week as the Engineering Society elections, which always take up much of the student's thought and attention, the attendance ranged from two hundred to three hundred on every occasion.

## Addresses by Mr. Lewis F. Moody, Philadelphia.

The course opened with two lectures on Feb. 27th by Mr. Lewis F. Moody, a graduate of the University of Pennsylvania, and for some years Professor of Hydraulics in Rensselaer Polytechnic Institute, but now Consulting Engineer for the I. P. Morris Department of William Cramp & Sons' Ship and Engine Co., Philadelphia.

Under the headings, "Some of the principles controlling the use and design of hydraulic turbines," and "Hydraulic turbines and installations," Mr. Moody presented very difficult theory of the turbine in a concise form, deriving the necessary equations and illustrating his work by slides and sketches. He also gave a large number of slides showing the very latest turbine designs and illustrating the new high speed turbine, in the development of which he has taken a prominent part. A brief summary of this lecture has been printed elsewhere.

The new forms of draft tube, mainly designed by Mr. Moody and applied to some of the largest plants in the world, were fully discussed and their theory explained, although the speaker carefully concealed his connection with the inventions.

### Address by Mr. Max V. Sauer.

The address by Mr. Sauer, a graduate of the University of Toronto and Hydraulic Engineer of Design for the Hydro Electric Power Commission of Ontario, dealt with the general considerations affecting the power house design and layout, and the speaker discussed various details of the plant. Starting with the selection of the turbine for a particular duty, Mr. Sauer discussed the exciters, governors, oiling systems, and other auxiliary equipment, laying much stress on the factor of reliability, which he regarded as more important than even the efficiency. The need of reliable oil pumps and air compressors was stressed and many practical points were mentioned.

During the discussion which followed many other points were brought forward and the session proved profitable and interesting.

### Address by Mr. T. H. Hogg.

The next phase of the development dealt with was the consideration of the Intake, Head Works, Power Canal or Conduit Surge Tank and Penstock, and Mr. Hogg, Assistant Hydraulic Engineer for the Hydro Electric Power Commission of Ontario, treated the matter in a most capable way. Having outlined some of the troubles due to ice, he explained the principles governing the intake design and next took up the matter of the canal itself, outlining the general method of handling the problem and giving many helpful ideas and suggestions as to how such a difficult problem could be solved, incidentally commending the methods now being taught at this University.

The problem of the surge tank took a fair share of Mr. Hogg's time, and he showed why it was needed, and worked out some problems, supplemented by his experience, to show how important it is to make proper allowance for surges. All that was possible was to indicate the method of solution, both this problem and the former one being examples of the use of arithmetical integration.

### Address by Mr. W. M. White.

The address by Mr. W. M. White, Hydraulic Engineer for the Allis Chalmers Co., Milwaukee, a graduate of Tulane University, proved a most valuable one. Mr. White had just returned to America after an extended trip in Japan, Formosa and the east, and spoke in a very interesting way of the developments in those countries in the hydraulic line, pointing out that they were realizing the very great value of water power in the progress of their nations.

Mr. White discussed primarily the Power House Machinery, showing how the draft tube affected the design and discussing the best form of the tube and the experiments that led to his conclusions. He also discussed the modern turbine development at some length and showed how the power house could be much simplified in good design, and also gave some interesting illustrations of how the best advantage may be taken of the head and volume and described some exceedingly novel power houses. His company was the only one, he said, which had supplied the most recent form of high speed runners to actual plants.

### Addresses by N. R. Gibson.

The two concluding lectures were given by Mr. N. R. Gibson, a graduate of the University of Toronto in 1902, and at present Hydraulic Engineer for the Niagara Falls Power Co., Niagara Falls, N.Y. Mr. Gibson has brought some distinction recently to his Alma Mater by two important researches of recognized merit.

In his afternoon address Mr. Gibson dealt with the Regulation and Testing of Turbines, and set out fully how the problem of regulation was affected by the dimensions of the pipe line and penstock and also by the changes of load. He then discussed at length the importance of efficiency determinations and the reasons why these must be made with accuracy, but at the same time he showed how difficult it was to measure some of the elements, more particularly the quantity of water flowing. Mr. Gibson's simple and precise solution of this problem is well known to engineers and is likely to be almost universally employed, and his description of it therefore proved of much interest, but the discoverer very modestly neglected to mention his connection with it.

The concluding lecture on the evening of March 6th was also by Mr. Gibson and in it he discussed the economic features of water power development, explaining the conditions where water power is preferable to steam, the meaning of rates, the effect of the "diversity factor," and many other of the very important points connected with the sale of power. He concluded his lecture by a splendid set of slides showing the progress being made by his company with the new tunnel at Niagara Falls, and also the advances made in hydraulic machinery as illustrated in the plant he is connected with.

Very general satisfaction has been expressed everywhere with the entire course of lectures both by engineers and students and the results have fully justified the effort put forth. Those who so kindly gave of their time and ability to deliver the lectures have very deservedly earned the gratitude of this University.

# SOME PRINCIPLES CONTROLLING THE USE AND DESIGN OF HYDRAULIC TURBINES*

### By Lewis F. Moody, Philadelphia

BEFORE going into the hydraulic principles governing the action of hydraulic turbines, it will be well to look for a moment at a few views showing some simple forms of turbines and typical power-house arrangements, so that we are clear regarding the things which we are going to discuss.

Let us first be sure that we understand the two general classifications of turbines, and the line of separation between them. We are confronted at the start with the two terms used to distinguish these two classes, and these terms are probably responsible for many misconceptions. The terms themselves do not distinguish and have little meaning.

Impulse turbines are those in which the water under pressure is discharged through nozzles or orifices and its potential energy converted into the kinetic form, so that the water issues with all of its head converted into the velocity form at atmospheric pressure, or pressure substantially atmospheric. The water in the form of a free jet or jets acts against one surface of a series of open buckets mounted on a revolving element and the action of the water in passing through this wheel takes place entirely at constant pressure; this whole action being open to the air.

In the so-called "reaction" turbine, on the other hand, the entire operation takes place in a closed system of passages, the water being everywhere under pressure different from that of the atmosphere and the flow not being open to the air. In the modern reaction turbine, the water is discharged through a ring of guide vanes which give it a rotary or whirling motion about the turbine axis, its initial potential energy being converted only in part into the kinetic form, a cosiderable portion still remaining as pressure head. The water is then passed through a rotating runner in which the energy is abstracted from the water, the water discharging into a closed draft tube at a pressure usually considerably less than atmospheric and with a considerable amount of kinetic energy or velocity head still remaining in the water.

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*This is one of the lectures in the Water Power Development course arranged by Professor Angus.

The above names used to classify turbines perhaps originated in the one case in wheels in which a jet impinged on a series of flat paddles, and in the other case in wheels having a series of rotating arms dischargingthe water in backwardly directed jets. The latter device, known as "Barker's Mill," which somewhat resembles a lawn-sprinkler, is a true reaction turbine in the sense originally intended. It is interesting to note that neither the modern impulse turbine nor reaction turbine operates on the principles of the primitive wheels just mentioned. It is worth noting that the high-speed reaction turbine of today actually discharges the water from the runner in the same direction as the motion of the runner, so that its reaction, in the sense used originally, is in the opposite direction to the rotation of the wheel, tending to oppose its motion. Furthermore, both turbines are dependent upon the impulse of the entering water to produce the driving torque. In the following discussion of principles, we shall direct our attention chiefly to the reaction turbine.

I believe that most of those present are thoroughly familiar with the theory of the turbine, but hydraulics is a subject so liable to misconceptions that I think it may be useful for us to touch briefly a few of the high spots of this particular branch. In approaching any hydraulic problem, there are two possible plans of attack, both of which are worth keeping in mind.

The first is to establish energy relations; that is, to find out what becomes of the energy involved; and the second is to establish the conditions of equilibrium under the forces of impulse and reaction, that is, to depend on the principle of momentum of the moving water.

The first method makes use of the Bernoulli formula, and the second utilizes the fact that a flowing stream or jet exerts in the opposite directions to its motion a reaction equal to $\frac{W V}{g}$, where W is the weight of water discharged per second; V the velocity in feet per second; and g the acceleration of gravity. If a jet is discharged into a tank so that its velocity is destroped, or if it impinges on a plate so that no velocity remains in the original direction, it exerts a forward impulse of the same amount.

Applying the first method, we can write the Bernoulli formula for the stationary parts of the turbine system, or any other system for that matter, as follows: (See Fig. 1.)

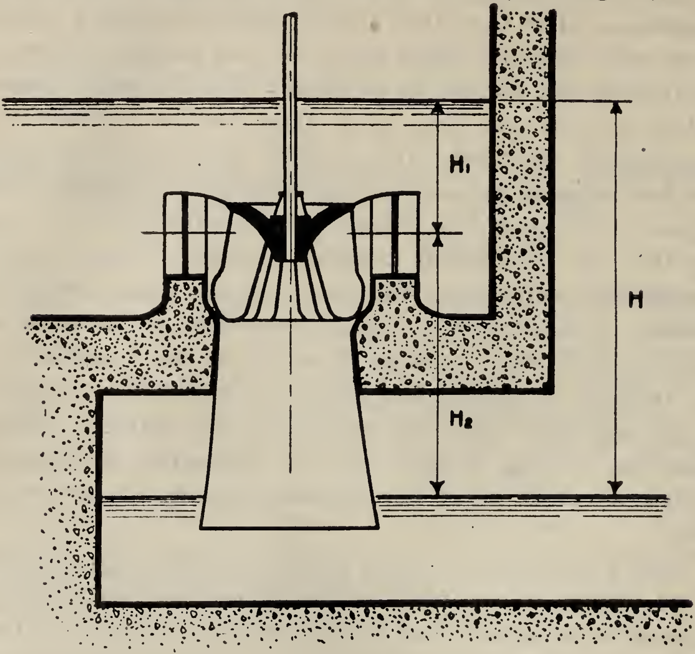

Fig. 1

From intake to entrance to runner

$$h_a + H_1 - L_1 = h_{p1} + \frac{c_1^2}{2g} \qquad (1)$$

From discharge from runner to tailwater

$$h_{p2} + \frac{c_2^2}{2g} + H_2 - L_d = h_a + \frac{c_3^2}{2g} \qquad (2)$$

in which $h_a$ = head corresponding to atmospheric pressure
$h_{p1}$ = absolute pressure head at runner entrance
$h_{p2}$ = absolute pressure head at runner discharge
$L_d$ = loss of head in draft tube
$c_1$ = absolute velocity of flow into runner
$c_2$ = absolute velocity of flow out of runner
$c_3$ = absolute velocity of flow out of draft tube

From entrance to discharge of runner. In writing this equation we must remember that in the runner a portion of the available energy is converted into useful work. A term must therefore be subtracted from the initial energy to leave the energy remaining at the runner discharge. The energy converted into useful work per second is W He, where H is the total effective head available for the turbine and e is the turbine efficiency. Since in this equation we are talking about head, and since head is the energy per pound of water, the amount of head converted into useful work is He. We therefore have

$$h_{p1} + \frac{c_1^2}{2g} - He - L_2 = h_{p2} + \frac{c_2^2}{2g} \qquad - \quad - \qquad (3)$$

Or, from (1) and (2), we can find the effective head on the runner by taking the difference between the sum of pressure and velocity heads at entrance and that at discharge, also subtracting the loss of head in the runner, thus:

$$\left(h_{p1} + \frac{c_1^2}{2g}\right) - \left(h_{p2} + \frac{c_2^2}{2g}\right) - L_2$$
$$= H_1 + H_2 - L_1 - L_2 - L_d - \frac{c_3^2}{2g}$$

The second term is evidently H — (the total loss of head) which is equal to He, and substituting this and transposing, we again have equation (3).

The above relations may appear to be so elementary that they are hardly worth stating; and yet they have not always been observed. In particular, many turbines have been located at a height $H_2$ above tail water, which requires in equation (2) an absolute pressure $hp_2$ amounting to less than zero.

Let us now go a step further and apply the Bernoulli formula with reference to the rotating system of the runner. The method of determining the flow in a rotating system may be explained in a simple manner. Suppose we have to consider two tanks on a merry-go-round at different distances from the axis of rotation and at different elevations. How shall we determine the flow through a connecting pipe? If the system is stationary, it is quite easy to do this by applying the Bernoulli formula between one tank and the other, just as was done above for the turbine intake. If the system is rotating, however, let us imagine first that we have a single large tank located below the two tanks to be investigated. (See Fig. 2.)

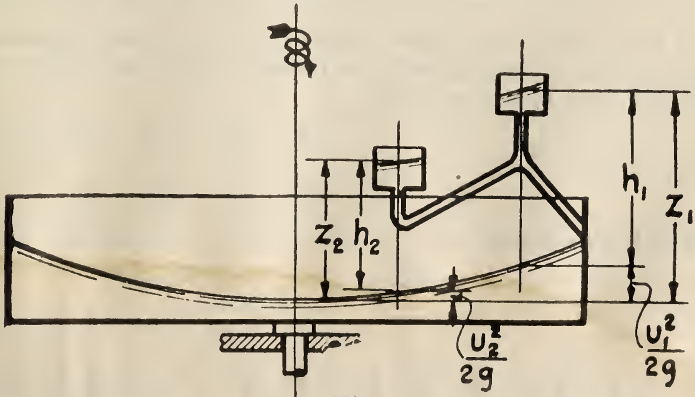

Fig. 2

The water surface in the large tank will take up the form of a paraboloid of revolution; and the difference of elevation at any two points in the surface, such as those just below the two tanks of the problem, is equal to the difference of the velocity heads corresponding to the rotation of the tank, that is, of the system. This difference of elevation is

$$\frac{u_1^2}{2g} - \frac{u_2^2}{2g}$$

Any particle in the water surface is in equilibrium and has no tendency to move either one way or the other. It is the amount of elevation above this surface which determines the head available to produce flow. Therefore, to apply the Bernoulli formula to such a rotating system, it is only necessary to measure all elevations above a paraboloidal surface corresponding to the speed of rotation. This surface becomes a datum surface, taking the place of a plane horizontal surface in stationary problems. Thus we have for the above problem:

$$\text{Head producing flow} = h_1 - h_2 = z_1 - \frac{u_1^2}{2g} - z_2 + \frac{u_1^2}{2g}$$

The effective head at any point of a rotating system is the sum of the pressure head, the velocity head due to the relative velocity, and the elevation head above the paraboloidal datum surface.

Applying this principle to the turbine runner from the point of entrance to the point of discharge, we therefore have

$$h_{p1} + \frac{w_1^2}{2g} - \frac{u_1^2}{2g} - L_2 = h_{p2} + \frac{w_2^2}{2g} - \frac{u_2^2}{2g} \qquad (4)$$

We can now obtain from either (3) or (4) an expression for the pressure drop through the runner and equating the two expressions thus found, we have:

$$h_{p1} - h_{p2} = He - \frac{c_1^2}{2g} + \frac{c_2^2}{2g} + L_2 = \frac{u_1^2}{2g} - \frac{u_2^2}{2g} - \frac{w_1^2}{2g} + \frac{w_2^2}{2g} + L_2$$

from which we obtain

$$He = \frac{c_1^2 - w_1^2 + u_1^2}{2g} - \frac{c_2^2 - w_2^2 + u_2^2}{2g}$$

Drawing the triangles at entrance and discharge from the runner to represent the relation between the relative and absolute velocities at these points, we have Fig. 3. Here $c_1$ and $c_2$ represent the absolute velocity of flow, and $w_1$ and $w_2$ the velocity considered relatively to the rotating system; $u_1$ and $u_2$ being the corresponding velocities of points on the rotating system itself, that is, the circumferential velocities at the points of entrance and discharge of the runner. These relations between the relative and absolute velocities can be expressed trigonometrically as follows:

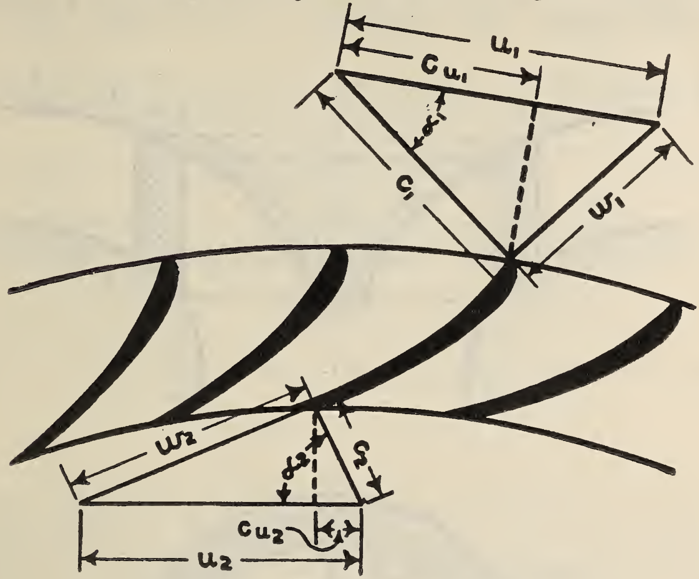

Fig. 3

$$w_1^2 = c_1^2 + u_1^2 - 2u_1c_1 \cos \alpha_1$$

If we denote by $c_{u_1}$ the tangential component $c \cos \alpha_1$ of the absolute entrance velocity, which we may refer to as the absolute entrance whirl, and similarily if we put $c_{u_2}$ for the absolute discharge whirl $c_2 \cos \alpha_2$ we shall have

$$c_1^2 - w_1^2 + u_1^2 = 2u_1\ c_{u_2}$$

By the substitution of these values, (5) reduces to the simple relation

$$u_1\ c_{u_1} - u_2\ c_{u_2} = gHe \qquad (6)$$

This equation is a fundamental one and forms a reliable basis for the design of a turbine. In the design of turbines of low specific speed $c_{u_2}$ may be taken as close to zero, and the second term may then be dropped. For the attainment of very high speeds, the second term may be given a considerable value in comparison with the first term. The turbine shown somewhat diagrammatically in Fig. 5 utilizes this principle.

If we approach the analysis of a turbine by the second method mentioned, we can proceed as follows:

Referring to Fig. 4, suppose we have a space bounded by

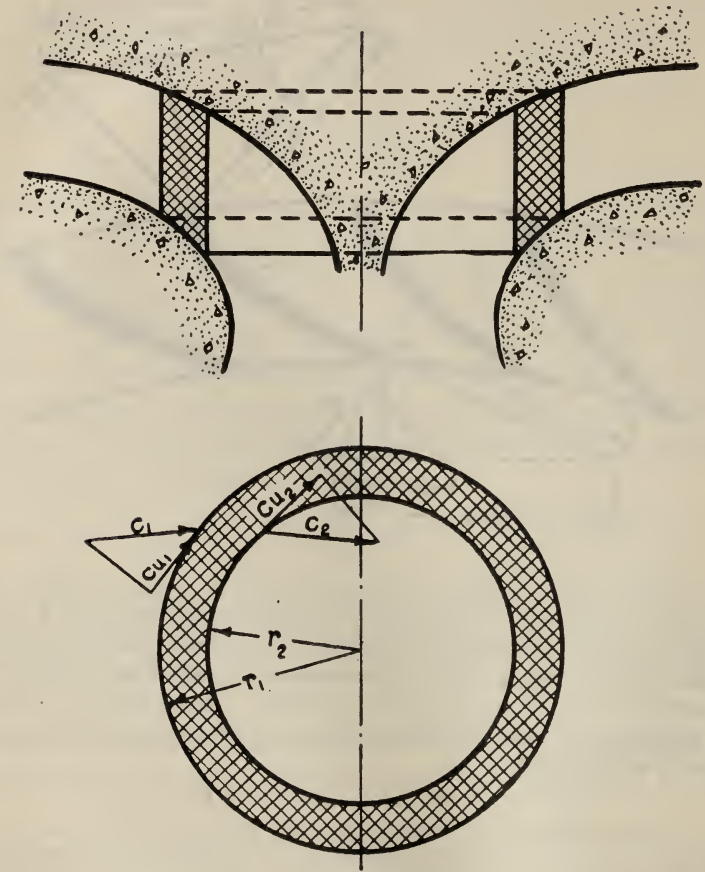

Fig. 4

surfaces of revolution swept up by rotating curves of any desired form about the axis, and let us suppose this space to be filled with water flowing inward around the periphery and outward at the bottom, this water being at the same time given an initial whirl in addition to its inward velocity. Suppose that the flow is steady, that is, the same from instant to instant, and consider the annular space marked by the double hatching. This ring is continually filled with water which is flowing in through its outer cylindrical surface of radius $r_1$ and out through its inner surface of radius $r_2$, and at any particular point in the space the velocity, pressure and other conditions will be constant with respect to time. This ring of water is therefore in equilibrium and the forces acting upon it are balanced, and the velocity at any point has zero acceleration. The water entering the ring-formed space exerts a force in the direction of its motion equal to its weight multiplied by $\frac{V}{g}$, and if the total weight of water entering per second around the periphery is W, the tangential component of the impulse of each elementary stream of water will be equal to the weight flowing multiplied by $\frac{c_{u1}}{g}$ and the moment exerted by all of the entering streams upon the ring of water tending to rotate it about the axis will be equal to

$$\frac{Wr_1\, c_{u1}}{g}$$

Similarly, the backward reaction of the entire leaving stream will be

$$\frac{Wr_1\, c_{u2}}{g}$$

the value of W, of course, being the same in both expressions, since the amount of water leaving is equal to that entering in accordance with continuity of flow. In such an elementary space containing no vanes, either stationary or rotating, there is no other force which can act upon the water in a circumferential direction and therefore the algebraic sum of the two turning moments must be zero or

$$\frac{Wr_1\, c_{u1}}{g} - \frac{Wr_2\, c_{u2}}{g} = 0$$

or $$r_{11}c_{u1} = r_2c_{u2} \quad - \quad - \quad - \quad - \quad - \qquad (7)$$

This relation applies to any unobstructed space in which water may freely rotate, and can therefore be applied, for example, to the water after it is discharged from the turbine guide vanes and before it enters the runner, and to the water in a draft tube which is bounded by surfaces of revolution co-axial with the runner.

The spiral casing for a turbine may also be so formed that the flow within it conforms to the above relation and the same thing applies to the casing of a centrifugal pump. The writer considers this to be the proper condition to observe in the design of such spiral casings as it permits the flow to conform with the natural conditions which would exist if the spiral guiding wall were absent.

Let us now consider the conditions which we would have if the space of Fig. 4, instead of being unobstructed, contained a series of vanes. In this case, the moments of the entering and leaving water would be no longer equal and opposite, but they would differ by the amount of the moment exerted against the vanes. (See Fig. 5.) In this way we would obtain for the moment exerted on the turbine runner the expression

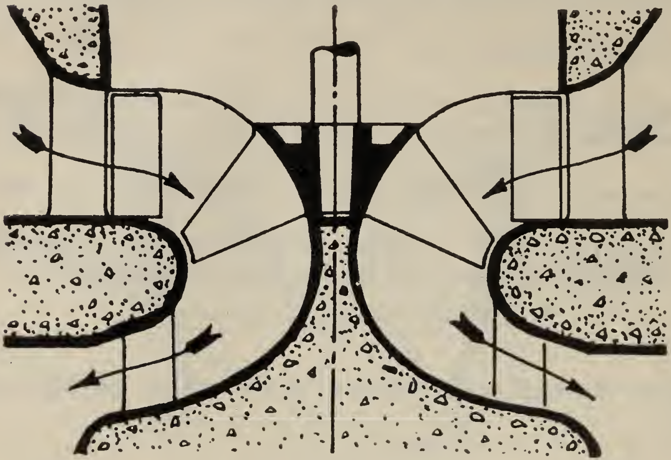

Fig. 5

$$\text{Moment} = \frac{W}{g}\ r_1 c_{u_1} - r_2 c_{u_2} \qquad - \quad - \quad - \qquad (8)$$

If we multiply this amount by the angular velocity $w$ of the runner, we shall have the work done by the runner per second, that is,

$$\frac{W}{g}\left(wr_1 c_{u_1} - wr_2 c_{u_2}\right) = WHe$$

or, in terms of circumferential velocities of the runner,

$$u_1 c_{u_1} - u_2 c u_2 = gHe$$

This result will be recognized as the same as that previously derived from energy considerations (6). Although derived for the modern turbine, this formula is applicable to all forms, both reactions and impulse turbines whether the flow is in a continuous ring or divided into separate jets.

These relations are, of course, not new, although there are probably many opportunities for applying them which have not been utilized. Equation (8) was announced by Leonhard Euler in 1754 and the principle of Equation (7) was known in the case of a vortex to Leonardo da Vinci.

More specifically, these principles, when applied to a spiral casing of a turbine, call for velocities at various points around the circumference which increase as the water approaches the axis, the velocity varying inversely as the radius according to equation (7). When applied to the transition space between the guide vanes and the runner, in a turbine of the type of Fig. 5, if we start with a given velocity of discharge from the guide vanes we can compute the velocity at various points along the entrance edge of the runner vane at different radial distances from the axis by multiplying the velocity in each case by the inverse ratio of the radii of the runner vane tips and the guide vane tips.

When applied to a draft tube formed as a surface of revolution (Fig. 5), this principle, which is simply an application of the principle of constancy of moment of momentum, calls for a velocity which automatically decreases as the distance from the axis increases. Such a draft tube, therefore, provides an excellent means for recovering the energy of whirl with which the water leaves the runner and permits the water to discharge from the outlet of the draft tube with very little energy of whirl remaining in it.

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## ESSAY ON "FIRE PREVENTION."

By T. S. Glover, Class of 1922, Civil Engineering.

"Now, altogether, hear them lift their lesson, theirs and mine,
Law, order, duty and restraint, obedience, discipline."
—Kipling.

PRIMITIVE peoples have made of fire a god. To us it is in danger of becoming a devil. One of the outward signs that distinguish man from the beasts of the field is the use of fire, and without it our civilization would have been impossible. The uses of fire are obvious, but the abuses of it are so little realized by the vast majority of people, that today we have special departments whose business is solely to shake us from our blissful slumbers, and hammer cold facts into our heads about the tremendous loss of life and property that is now, hourly, going on round about us. The expression "hammer" is used purposely, as any milder form of persuasion is useless, and can never succeed in breaking through our attitude of indifference to this glaring evil.

### A Personal Problem.

Those of us who have considered the human make-up (and which of us has not) are eager to admit the beauty of self-control, of the strong and healthy mind that leads. We admire the great efforts that the engineer has made in controlling and directing Nature by dams, canals and all the many works he has designed. And yet, in the face of this lawless devil, Fire, that tears madly through our land, respecting neither low nor high, waving his red torch of destruction, we placidly go about our business, hoping that we at least may be spared. Then perhaps we see a fire, or read about some new triumph of the demon of fire, and wonder why someone does not do something to prevent this waste. When we have reached this point there is some hope of improvement. In the particular circumstances in which each one of us is placed there is opportunity to awaken people to a sense of the futility of this fire wastage, and it is only when the great mass of public opinion decides that this shall not be that it will cease. There are men with brains to design fireproof structures if we want them. Till we want them enough to be willing to pay the comparatively small extra cost the same orgy will continue.

### Care in Trifles Necessary.

We therefore want to prevent loss by fire. The word "prevent" means "coming before," or, as we should say, "getting ahead of." Our fire demon is endowed with intelligence of a high order, but nevertheless we have sufficient accumulated knowledge to be able to forestall his machinations, if we really set out to do it. Our frame house, lit by kerosene lamps, is an easy mark for him, and with what fiendish delight does he pounce on the little child playing by the unguarded fireplace. The airy tossing of our cigarette end into space, or what is more likely, into the waste-paper basket, is as good an opening for him as that offered by the man who looks for a gas leak with a candle. It is not so much technical knowledge we need, as ordinary common sense and a stiffening of our mental and moral fibre. We are so used to the comforts and conveniences of our modern life that we see no reason why we need go to a little trouble in the small things of our daily round.

### Value of Education.

In a recent address before the Ontario Fire Prevention League, Dr. H. J. Cody stated that in his opinion the best way to bring about a great national advance or induce a beneficial national change, was to deal with the children. Train the child, and then, as the twig is turned, so will the tree be. It is far better to deal with the children than with the adult.

This means education, not by the teaching of a long list of "dont's" so much as by the inculcation of strong positive principles, such as cleanliness, law, order, duty and restraint, obedience, discipline. The child with a clear and well-ordered mind will instinctively refrain from untidy and slack practices, such as letting off squibs in the woodshed. He will know enough to go out into a field for the fireworks season. To quote Dr. Cody again, "The two great enemies of property and of fire prevention work are probably carelessness and uncleanliness: both of these have their roots in certain features of human nature. They are not merely material accidents, but are related to personality, and so, being related to personality, can be dealt with by the processes of reason and education along proper lines."

### Loss in Life and Property.

Facts are very potent, solid arguments, and if there are any who need convincing of the magnitude of the danger, let them ponder the following. In the United States and Canada, estimates show a casualty list of twelve thousand persons killed each year by fire. As in war, the deaths are not nearly equal to the injured, so that thirty thousand casualties a year from fire is no exaggerated estimate. The loss of material property from the same cause exceeds three hundred million dollars. Much of this loss is foodstuffs, and necessaries of life, a waste which is positively criminal. And who is responsible? In some cases the builders and architects, but in far more cases some foolish and careless person who handles fire in the form of matches, burning tobacco, and a hundred other forms. Those who have investigated the facts closely tell us that in Europe conditions are not nearly so bad. The reason is that the people have been educated, and know the dangers of fire, and the precautionary measures to be adopted against it. They realize that their country's prosperity depends on the efficiency of its people and industrial plants, and that the matter is not merely one which concerns insurance companies and fire brigades, but that it is the concern of each member of the community.

In this country the recent efforts of the Fire Prevention League have resulted in a very marked decrease in fire losses. In Ontario, during the first six months of 1919, a reduction of 40 per cent. was effected—proof that the educational methods used were sound.

### Defective Construction.

Assuming now that the sympathy and co-operation of the large body of loyal citizens has been enlisted, let us turn to examine the responsibility of the structural engineer in the matter of fire prevention. Competent authorities state that the largest single factor contributing to the excessive fire waste in Canada is the indiscriminate use of wood for structural purposes. Out of possibly two million buildings, less than one-tenth of one per cent. has been built with proper consideration of fire safety. Nearly 70 per cent. of our buildings are of frame construction, and the majority of our brick buildings are inadequately protected against fire. It must, therefore, necessarily be a long time before the effect of more stringent building regulations will be felt and the problem consequently becomes not merely one of building new fireproof structures, but of remodelling existing ones so as to give a much greater factor of safety against fire.

Comparison of fire losses and of structural conditions in Canada and Europe leads to the conclusion that a radical change in building methods is fundamental to the curtailment of Canada's fire losses. Serious fires in Europe are exceptional occurrences, and conflagrations are almost unknown now. The fire departments in the principal European cities are certainly no better than ours, and in the smaller places, comparison would be ludicrous. Their greater immunity from destructive fires is undoubtedly due in large measure to superior construction.

A lack of thoroughness marks a large amount of our Canadian building, due to our giving way to the modern cry for speed. This leads to insufficient supervision and carelessness, not in the matter of structural safety, but of safety against fire. The responsibility for these conditions may be equally divided between the owners, architects, contractors and public authorities. Speculation and the desire for large returns by investors have been the cause of much poor construction in Canada. Efficient construction requires time.

Objection has been frequently made to the passage of ordinances requiring brick construction, on the ground that it would prove a hardship to builders by compelling a larger initial expenditure. After careful examination of the merits of this argument, it has been found that the additional cost in Canada of solid construction is so small that the prohibition of frame buildings, at least in cities and towns, would involve no real hardship.

### Hazards to Life.

The relation of construction to the safety of the lives of those who occupy buildings is self-evident. The danger to human life is influenced by (1) the material used in construction, (2) the design, (3) the facilities for escape, and (4) the physical and mental condition of the occupants. It is clear that the materials should be incombustible, and be employed in such manner as to overcome any inherent defects or weaknesses. Unfortunately, a building, even when constructed of fire-resistant material, and equipped with every safety feature and device, may be filled with inflammable and combustible contents, capable of generating gases, smoke and heat sufficient to destroy the lives of the occupants. Well designed and constructed fire resistant walls will, however, confine a fire to the space in which it originates.

The safety of a building is largely influenced by its design. The maximum separation of the exits, the safe enclosure of the stairways, the proper introduction of fire walls and the character and degree of the fire protection are all important details. In order to secure economy of design it is necessary that the purposes and uses of the building should be definitely known. Thus, the correct amount of fire protection may be provided against the exterior fire hazard, and, by dividing walls or partitions, fire-doors and fire-extinguishing apparatus and equipment, protection may be provided internally.

### Value of Fire Walls.

The usual means of exit are (1) elevators, (2) outside fire escapes, (3) stairways, and (4) the fire-wall. There are only two kinds of safe exits—the enclosed fireproof stairway and the fire-wall—but the former has serious limitations and is not suitable for crowded buildings. The only real and practical solution of the problem of safety in buildings is a bi-sectional fire-wall. It is, moreover, the least expensive solution of the problem if properly and economically applied. There is, unfortunately, a widespread prejudice against the fire-wall, but this is largely due to the lack of knowledge of the manner of its application to the life hazard.

Its merits and advantages as a safeguard and protection to property have long been recognized by underwriters. , Where it is introduced, the conditions in buildings are so changed that large economies can be made in the cost of additional exit facilities. In most cases this saving more than offsets the entire cost of the fire-wall and materially reduces the total cost of the building. There should be at least one stairway and one elevator on each side of the fire-wall and the wall should have at least two openings in it at as great a distance from each other as practicable, and both should be closed by standard fire-doors.

It is improbable that a fire will occur on both sides of the fire-wall simultaneously. Should it occur on one side, the people on that side would pass through the doorways in the fire-wall, close the doors after them and be perfectly safe. The half of the building in which the fire occurs can usually be emptied in less than a minute if there are not more than 300 people on each floor, and an average of 150 have to pass through the doorways. If the principle of the horizontal escape presented by the fire-wall is correctly applied in new buildings, a most satisfactory method of securing safety at comparatively small expense will be obtained.

The minute details of this work afford material for a long course of study in themselves, and the engineer has first of all, in designing any structure, to consider its strength to bear the load expected of it. But this does not imply an absolute disregard of the principles of fire protection. On the contrary, a closer study of such principles is becoming a necessity in our engineering colleges, if we are to proceed in the campaign for education in fire prevention equally at all points of the line.

## THE CANADIAN INSTITUTE OF CHEMISTRY.

By Prof. J. Watson Bain, President.

THROUGHOUT the greater part of Canada the titles "chemist" or "chemical engineer" may be freely used by any person whomsoever, without fear of prosecution under the law. As a natural consequence a number of persons, quite unfitted either by training or experience, have, by assuming these names, misled the public into disastrous investments, or into futile expenditures for experimental purposes. It may safely be stated that there is no graduate from a chemical course in a university with five years of professional experience who has not had a considerable acquaintance with the quack chemist and with the financial losses which his trusting clients have suffered.

In the light of this situation, the resolution of a large number of professional chemists, gathered at a convention in Ottawa in 1918, to form an organization for the purpose of elevating the status of the chemist in Canada requires no detailed explanation, and after a year's careful study of the matter, a second convention of Canadian chemists in Montreal in 1919, decided to form a Canadian Institute of Chemistry. Members were enrolled and a council was elected; the drafting of a constitution and by-laws was commenced which proved to be a difficult and laborious task. Only in August, 1921, did the Institute secure its charter from the Dominion Government and commence its career legally, although in point of fact it had been growing and functioning vigorously since its birth in 1919.

There are two classes of members: Fellows and Associates, entitled to use the letters "F.C.I.C." and "A.C.I.C." after their names respectively.

The Institute aims primarily to raise the standard in the profession, and to this end admits to its membership only those who are qualified by training and experience. Judging from the record of the Institute of Chemistry of Great Britain, which has now been in existence for 45 years, every chemist practising outside the universities will consider the appending of these four letters to his name as an honorable distinction and a valuable asset.

During their college course, students are invited by the Institute to join its ranks as student members; a year after graduation, with suitable experience, they may become Associates, and with further experience, Fellows. The older men in the profession secure little value for their membership, for their positions are already established; the younger men, on the other hand, have everything to gain by allying themselves with the movement for raising the professional status. To every young chemical engineer or chemist, who reads this, I would say: This is more your business than it is mine; if you are not interested in your professional future, who else will be?

# STRESS ANALYSIS.

T. R. Loudon.

IN the following discussion will be found outlined methods of determining the stress on various planes in material subjected to the deforming action of external forces. Stress is the resistance offered by material to any effort to change its shape. Just what constitutes the ultimate nature of this resistance is a question that is involved in the discussion of atomic structure, mass and energy; an extremely interesting problem, but a still somewhat speculative investigation.

The mathematical analysis of stress in three dimensions is rather complicated, but should the reader desire to pursue further the subject as outlined in two dimensions in these pages, a bibliography will be found at the end of the article from which the necessary information may be obtained.

The state of stress in a body is related necessarily to the deformations or strains in the material under discussion. In the following argument, the strains are entirely neglected and the subject approached from a purely Statical standpoint. This method is somewhat easier to follow and gives results that are as close to those deduced from practical experiments as does the method of determining stress by considering the strains. For it must be remembered that neither method can take into account the variations of internal structure that are to be found in even the most so-called homogenous materials, which variations of structure will always modify the stress distribution to a certain extent.

## Simple and Oblique Stresses.

When a body is acted upon by two equal external forces P, such as indicated in Fig. 1, the material resists internally and at any plane section AB there is said to exist a stress; that is, the forces exerted by the smallest particles on one another on each side of the section maintain a condition of equilibrium. What the ultimate composition of these minute particles is need be of no concern for the present; nor need the exact nature of what are called forces acting on and between these particles be determined. It is sufficient to recognize that there is some form of resistance along the plane section which prevents the external deforming action from disrupting the material.

If the external forces P, Fig. 1, are properly applied, it is possible to get a uniformly distributed stress on the section AB; that is, as the name uniformly distributed implies, each unit of area on the plane has the same stress or resistance. The numerical magnitude of the unit stress on a plane subjected to uniformly distributed stress is found by dividing the total stress on the plane section by the area of the section.

In the majority of cases, it is merely necessary to determine the unit stress or intensity of stress, as it is sometimes called, on a plane which has the stress acting entirely normal to it. Such planes are generally easy to locate, as in most cases they are perpendicular either to a well defined axis of a structural member or they are taken perpendicular to the line of action of an external force which produces the stress.

For instance, if the problem were to determine the unit stress in the material represented by Fig. 1, the natural tendency is to assume that the stress on a plane AB perpendicular to the line of action of P is what is required, and in most cases the assumption would be correct. Indeed the plane along which the unit stress is required is so obvious in most problems that no mention is made of its direction; but, as will be seen with a little consideration, this assumption as to method of procedure is likely to lead to a misconception and disregard of the nature of stress on other planes, if perhaps the existence of stress on other planes is not entirely forgotten. It should be definitely understood that stress exists at all plane sections in material subjected to deforming action. The magnitude and nature of the stresses on the various planes of course differs with the inclination of the planes.

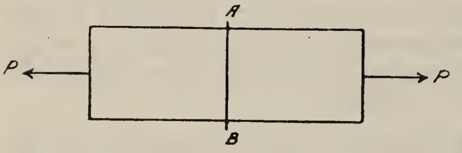

Fig. 1

In order to see more clearly the nature of the resistance on planes other than those having stress acting normal to them, it will be found convenient in all cases to isolate a small rectangular element from the material. Let Fig. 2 represent such an element isolated from Fig. 1, the sides AB and DC of which have a normal unit stress p acting on them as a result of the external forces P. It will further simplify matters if the thickness of this element be taken as unity.

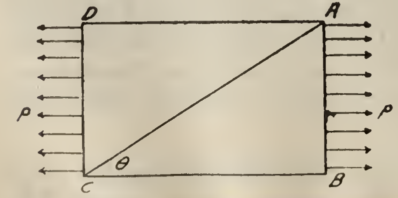

Fig. 2

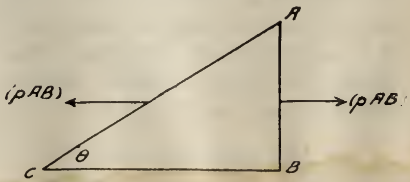

Fig. 3

Consider any plane section CA inclined at an angle $\theta$ to the unit stress p. This section need not be taken necessarily from

C to A. Any section will allow the same Algebraic analysis to be applied, but the one taken gives a slightly more concise figure to discuss.

Consider the equilibrium of the portion of material ABC. Acting on the side AB, **which it will be remembered is of unit thickness,** there is a total stress (p.AB). This total stress is represented in Fig. 3 as a single Resultant Force.

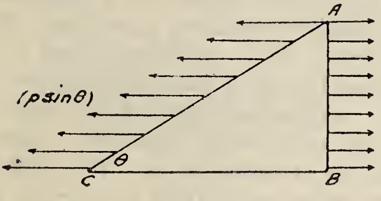

Fig. 4

Now since the material ABC is in equilibrium, another force (pAB) must act at some point on CA as represented. But this force acting on CA is in reality the Resultant of a uniformly distributed stress on the plane section CA, of which the unit stress may be found by dividing the total force (p.AB) by the area of section CA. If -r- represent this unit stress,

$$r = p\frac{AB}{CA} = p \sin \theta \quad \ldots\ldots\ldots\ldots (1)$$

It is seen, then, that as a result of the uniformly distributed unit stress p acting on AB, there is uniformly distributed unit stress (p sin $\theta$) acting on CA as represented in Fig. 4. This unit stress (p sin $\theta$), since its direction is inclined to the plane CA, is called an Oblique Stress.

The effect of an Oblique Stress is seen more readily if its Resolved Parts perpendicular and parallel to the plane on which it acts are found. In order to determine these Resolved Parts, consider again the total stress (pAB) acting on CA as shown in Fig. 3. The desired Resolved Parts of this total force are shown in Fig. 5. Bearing in mind that these Resolved Parts replace a uniformly distributed stress, it follows that each Resolved Part may be considered as being uniformly distributed over CA and the unit stress of each derived separately by dividing (pAB sin $\theta$) and (pAB cos $\theta$) by the cross section area of CA.

Let x and y be respectively the unit stress parallel and perpendicular to CA

$$x = p\frac{AB}{CA} \cos \theta) = p \sin \theta \cos \theta = \tfrac{1}{2}p \sin 2\theta \quad \ldots\ldots\ldots\ldots (2)$$

$$y = p\frac{AB}{CA} \sin \theta = p \sin^2 \theta = \tfrac{1}{2}p\ (1 - \cos 2\theta) \quad \ldots\ldots\ldots\ldots (3)$$

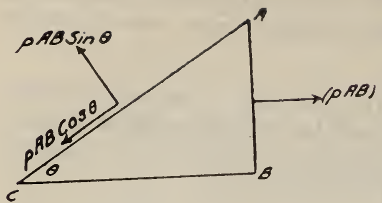

Fig. 5

It will be seen from this that an oblique unit stress on CA may be considered as having two effects. Firstly, a unit stress acting normal to the plane CA of magnitude $\frac{1}{2}p\ (1 - \cos 2\theta)$. Secondly, a unit stress acting parallel to the plane which is equivalent to a shearing stress of magnitude ($\frac{1}{2}p$ sine $2\theta$).

The maximum values of these equivalent normal and shearing unit stresses on CA may be found by differentiating equations (2) and (3). The normal unit stress will be a maximum and the shearing unit stress a minimum when $\theta = 90°$. The shearing unit stress, on the other hand, reaches a maximum value of $\frac{1}{2}p$ when $\theta = 45°$ and it is because of this maximum shearing value that the necessity of discussing oblique stresses arises. It is seen that on planes inclined at 45° to the given unit stress p, there is a shearing effect which gives a unit shearing stress equal to $\frac{1}{2}p$. So that if the material has a shearing strength less than one-half its tensile or compressive strength, failure may take place not by tension or compression, as might be expected, but by shearing on some plane inclined roughly at 45° to the tensile or compressive external forces. This type of failure is quite common in compression tests on brick, concrete and cast iron.

## Compound Stress.

In many cases, material is subjected to the deforming action of external forces which give an internal condition that may be analyzed as compounded of two or more stresses on planes inclined to one another.

Planes on which the Resultant stress is entirely normal are called Principal Planes and the Resultant stresses acting on them are called Principal Stresses. Sometimes it will be found convenient, as in the last problem, to take an Oblique Stress and replace it with equivalent Normal and Shearing Stresses. Such equivalent Normal Stresses must not be confused with Principal Stresses. An equivalent Normal Stress acts in conjunction with an equivalent Shearing Stress to produce the same effect as the Oblique Stress they replace. **Principal Stresses, on the other hand, are normal to and are the only stresses acting on Principal** Planes.

In the following, merely three cases will be discussed, namely: a body subjected to two tensions; a body subjected to tension and compression; and a body subjected to tension and shear. In these problems will be found the methods which may be applied to analyze any conditions of stress should the reader have occasion to do so.

### Two Tensile Stresses Acting Perpendicular to One Another.

Let Fig. 6 represent a rectangular element of unit thickness of a piece of material subjected to two tensions acting perpendicular to one another and normal to the sides of the element.

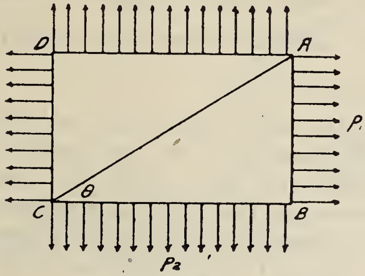

Fig. 6

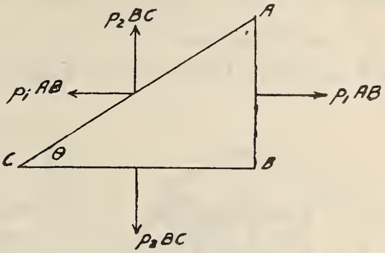

Fig. 7

It is required to find the stress acting on any plane CA which is inclined at an angle $\theta$ to the stress $p_1$.

Fig. 7 represents the total stresses which must act on the portion ABC of the element to preserve it in equilibrium. As in the previous problem, these total stresses are represented as single Resultant Forces for the sake of conciseness.

The Resultant R of the two forces $(p_1AB)$ and $(p_2BC)$ acting on CA is of magnitude $\sqrt{(p_1AB)^2 + (p_2BC)^2}$ and will act in a direction which is dependent on the relative magnitudes of $p_1$ and $p_2$. In general, this Resultant will act in some direction other than normal to CA and will consequently give an Oblique Stress on CA. Fig. 8 represents the forces now determined as acting on ABC. Now since $p_1$ and $p_2$ are uniformly distributed unit stresses along AB and BC respectively, the Resultant Force R must represent a uniformly distributed stress along CA, the unit stress of which is found by dividing R by the cross section area of CA. Let r represent the Resultant unit stress on CA:

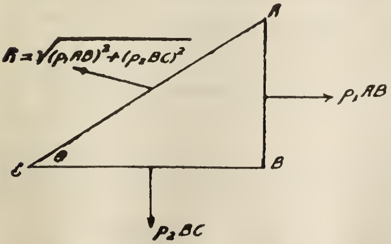

Fig. 8

$$r = \frac{R}{CA} = \sqrt{p_1 \frac{AB}{CA})^2 + p_2 \frac{BC}{CA})^2} = \sqrt{p_1^2 \sin^2\theta + p_2^2 \cos^2\theta}$$

That is, as a result of unit stresses $p_1$ and $p_2$ on AB and BC respectively, there will be a Resultant unit stress

$$r = \sqrt{p_1^2 \sin^{2\theta} + p_2^2 \cos^{\theta}}$$

acting on CA, which in most cases will be an Oblique Stress.

The Resultant Unit Stress may be determined very readily by Graphical Methods, as follows:

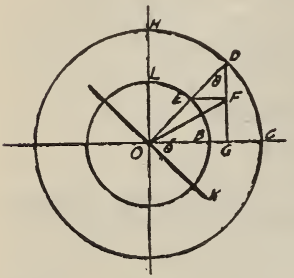

Fig. 9

Choose any pair of axes OC and OH Fig. 9 perpendicular to one another. With centre O and radii OC and OB representing the given unit stresses $p_1$ and $p_2$ respectively describe two circles. Draw OK making with OC an angle $\theta$ equal to the angle of inclination to $p_1$ of the plane on which it is desired to find the Resultant Unit Stress. From O draw OD perpendicular to OK. From D draw DG perpendicular to OC. From E draw EF perpendicular to DG. Join OF. Then OF will represent the required Resultant Unit Stress in magnitude and direction.

$$\begin{aligned} \text{For} \quad OF &= \sqrt{OG^2 + FG^2} \\ &= \sqrt{OD^2 \sin^{2\theta} + OE^2 \cos^{2\theta}} \\ &= \sqrt{p_1^2 \sin^{2\theta} + p_2^2 \cos^{2\theta}} \end{aligned}$$

Further, it may be shown that if the Resultant Unit Stress be found for all planes inclined to $p_1$, the point F in each case will lie on the circumference of an ellipse whose major and minor axes are OC and OL respectively. Such an ellipse is called an Ellipse of Stress. Unfortunately, it is not possible in such short space to go into a discussion of the information that may be obtained from the Ellipse of Stress.

Now, instead of determining the Resultant Unit Stress on the plane CA, it is often found more convenient to derive the Resolved Parts of this stress perpendicular and parallel to CA, finding thereby the equivalent of the Resultant Unit Stress in terms of a Normal and a Shearing Unit Stress. This is best arrived at by again considering Fig. 7 and resolving the forces acting on CA in directions perpendicular and parallel to CA. It will be found easier to do this than to take the Resultant Force

R, Fig. 8, and resolve it in the desired directions, as it would be first necessary to derive an expression for the inclination angle of R to CA which is a somewhat involved procedure.

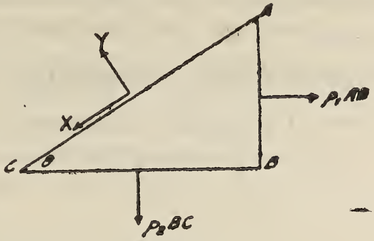

Fig. 10

Let Y and X, Fig. 10, represent the algebraic sum of the desired resolved parts of the forces acting on CA, Fig. 7.

$$Y = p_1 AB \sin\theta + p_2 BC \cos\theta$$

$$X = p_1 AB \cos\theta - p_2 BC \sin\theta$$

But, as pointed out before, since $p_1$ and $p_2$ are uniformly distributed, it follows that Y and X may be considered as uniformly distributed over CA. The unit stresses of Y and X may be found by dividing Y and X by the cross section area of CA. Let y and x represent the unit stresses from Y and X respectively.

$$y = p_1 \frac{AB}{CA} \sin\theta + p_2 \frac{BC}{CA} \cos\theta$$

$$= p_1 \sin^2\theta + p_2 \cos^2\theta \quad \ldots\ldots (5)$$

$$x = p_1 \frac{AB}{CA} \cos\theta - p^2 \frac{BC}{CA} \sin\theta$$

$$= p_1 \sin\theta \cos\theta - p_2 \cos\theta \sin\theta$$

$$\tfrac{1}{2}(p_1 - p_2) \sin 2\theta \quad \ldots\ldots (6)$$

It is seen now that as a result of the unit stresses $p_1$ and $p_2$, there is a Resultant unit stress on CA to which there are equivalent unit stresses normal and parallel to CA whose values are given by equations (5) and (6).

The most interesting case that arises with two tensions such as have been discussed is when $p_1$ equals $p_2$. In this case, the equivalent unit shearing stress x becomes equal to zero for all inclinations of the plane CA which may be seen by putting $p_1 = p_2$ in equation (6). This means that the Resultant Unit Stress must act entirely normal to all planes and is of the same magnitude in each case. The ellipse of stress then becomes a circle.

One of the best practical illustrations of material subjected to two tensions as discussed above is the case of the shell of a boiler which is under circumferential and longitudinal tension, which stresses may be analyzed by the methods just discussed.

**Compression and Tension Acting Perpendicular to One Another.**

Let Fig. 11 represent a tensile unit stress $p_1$ and a compressive unit stress $p_2$ acting on a rectangular element normal to the sides as shown.

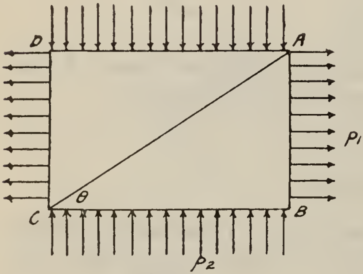

Fig. 11

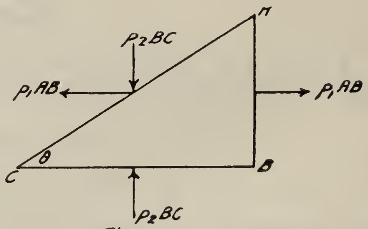

Fig. 12

Following out the same method of analysis in this case as in the last problem, Fig. 12 represents the total stresses which must act on ABC to hold it in equilibrium.

By vectorially compounding $p_1$ AB and $p_2$BC which act on CA, the Resultant Unit Stress r is found to have the following magnitude:

$$r = \sqrt{p_1^2 \sin^2 \theta + p_2^2 \cos^2 \theta}$$

The inclinations of this Resultant Unit Stress r will depend upon the relative values of $p_1$ and $p_2$.

Again considering the forces acting on CA as shown in Fig. 12, and determining their Resolved Parts perpendicular and parallel to CA, the Normal and Shearing Unit Stresses equivalent to the Resultant Unit Stress on CA may be found. The method of procedure is the same as outlined in the last problem, care being taken to add the different resolved parts in the proper algebraic manner. If the normal and shearing unit stresses are designed by y and x respectively:

$$y = p_1 \sin^2 \theta - p_2 \cos^2 \theta \quad \text{.......................................} (8)$$

$$x = \tfrac{1}{2} (p_1 + p_2) \sin 2\theta \quad \text{.......................................} (9)$$

These equations give some interesting results. For instance, if $p^1 = p_2$ and $\theta = 45°$, there will exist only a shearing unit stress on CA equal to either $p_1$ or $p_2$. So that with certain materials, under the conditions of tension and compression as shown in Fig. 11, failure will occur most likely by shearing on a plane inclined at 45° to the given equal tensile and compressive stresses; as few materials have a shearing strength approaching, let alone equal to, the tensile or compressive strength.

### Tension and Shearing Stresses Acting Together.

If a body be subjected to shearing action, at any point in the body, there will exist two shearing unit stresses of equal magnitude acting perpendicular to one another. The proof of this statement may be found in any of the references given at the end of the article.

Fig. 13 represents a rectangular element of material subjected to a unit tensile stress p and to unit shearing stresses q as indicated.

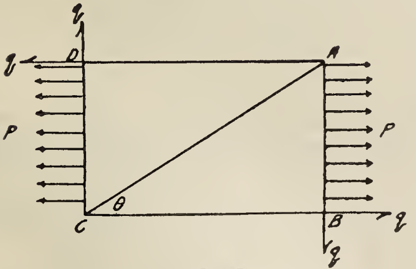

Fig 13

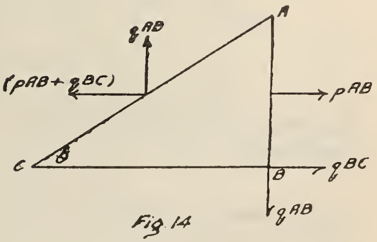

Fig 14

It is required to find the stress on any plane CA inclined at an angle $\theta$ to the tensile stress p.

Considering the equilibrium of the body ABC as in the former problems, there will act on AB a total tensile stress (pAB) and a total shearing stress (qAB); on the side BC, there will act a total shearing stress (qBC). Fig. 14 represents these total stresses as Resultant forces. It follows then that the body ABC being in Equilibrium, there must act on CA the forces (pAB + qBC) and (qAB) as shown.

Resolving the forces acting on CA, Fig. 14, perpendicular and parallel to CA and dividing the Resolved parts by the cross section area of CA, the unit stresses y and x normal and parallel to CA are determined as follows:

$$y = \left(\frac{pAB}{CA} + \frac{qBC}{CA}\right) \sin\theta + \frac{qAB}{CA} \cos\theta$$

$$= p \sin^2\theta + q \cos\theta \sin\theta + q \sin\theta \cos\theta$$

$$= p \sin^2\theta + q \sin 2\theta$$

$$= \tfrac{1}{2}p\,(1 - \cos 2\theta) + q \sin 2\theta \quad \ldots\ldots(10)$$

$$x = \left(\frac{pAB}{CA} + \frac{qBC}{CA}\right) \cos\theta - q \frac{AB}{CA} \sin\theta$$

$$= p \sin\theta \cos\theta + q \cos^2\theta - q \sin^2\theta$$

$$= \tfrac{1}{2}p \sin 2\theta + q \cos 2\theta \quad \ldots\ldots(11)$$

Differentiating these for maximum values, it will be found that the normal unit stress y on any plane CA has a maximum value when

$$\tan 2\theta = -\frac{2q}{p} \quad \ldots\ldots(12)$$

and the shearing unit stress x on any plane CA is a maximum when

$$\tan 2\theta = \frac{2q}{p} \quad \ldots\ldots(13$$

If from (12) the values of sin 2θ and cos 2θ be omitted and placed in equation (10) the maximum value of y will be found, such that

$$y \max = \tfrac{1}{2}p \pm \sqrt{q^2 + \frac{1}{4} p^2}$$

Following the same procedure with equations (13) and (11), the maximum value of x is obtained.

$$x \max = \sqrt{q^2 + \frac{1}{4} p^2}$$

Thus, if given the unit tensile stress and the unit shearing stress, it is possible to determine the values of the maximum, normal and shearing unit stresses and the inclination of the planes on which these maximum stresses act.

In some cases, it is more essential to determine the planes on which the given stresses produce a resultant unit stress acting entirely normal to the plane; in other words, to determine the Principal Planes. The stresses acting on these Principal Planes will then be Principal Stresses.

Let Fig. 15 represent the total stresses acting on the sides AB and BC of the body ABC. Fig. 13. Required to find the angle $\theta$ which will give a Resultant unit stress r acting normal to CA. The total stress acting on AC to preserve the equilibrium of ABC will be (r. CA.). Resolve the force (rCA) parallel to the sides AB and BC giving the resolved parts (rCA) cos $\theta$) and (rCA sin $\theta$) as shown in Fig. 15.

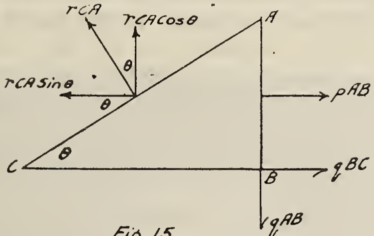

Fig. 15

It is seen that since ABC is in Equilibrium, the following relations must be true:

$$rCA \cos\theta = qAB$$

$$r = q \tan\theta \quad\text{.......}(14)$$

$$rCA \sin\theta = pAB + qBC$$

$$r = p + q \cot\theta \quad\text{.......}(15)$$

Placing equations (14) and (15) equal to one another;

$$q \tan\theta = p + q \cot\theta$$

$$\text{or } \cot 2\theta = -\frac{p}{2q} \quad\text{.......}(16)$$

That is, when cot 2$\theta$ is equal to the tensile unit stress divided by twice the shearing unit stress, the plane CA is a Principal Plane and has only a normal stress acting on it.

Equation 16 shows that there must be two Principal Planes perpendicular to one another, for there are two values of angle 2$\theta$ differing by 180° for which (16) is true. It follows, therefore, that there will be two planes inclined at $\theta$ and (90° + $\theta$) for which the relation is true.

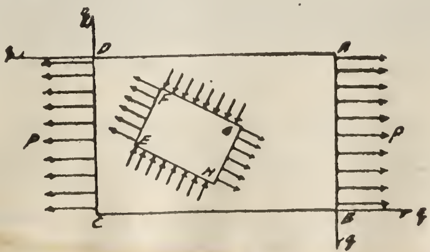

Fig. 16

It is seen from the above discussion that as a result of the given tensile and shearing stresses such as might be found on the tension side of a beam, there are two Principal Planes on which the stresses act entirely normal. Fig. 16 shows this diagrammatically. ABCD is the given elementary rectangle subjected to stresses p and q, and EFGH is another rectangle which may be determined and on which the stresses act entirely normal as indicated. EF, FG, GH and HE are Principal Planes and the stresses acting on these are Principal Stresses.

In all of the above discussion there has been a condensing of the argument from lack of space to go more fully into detail. Should the reader have occasion to go into the subject more deeply, there will be found in the following references sufficient information with which to solve almost any problem in compound stress:

History of the Elasticity and Strength of Materials—Todhunter and Pearson.
Treatise on the Theory of Elasticity—Love.
Mathematical Theory of Elasticity—Ibbetson.
Mechanics of Materials—Merriman.
The Theory of Structures—Morley.
Applied Mechanics for Engineers—Duncan.

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# S.P.S.---1878---1891

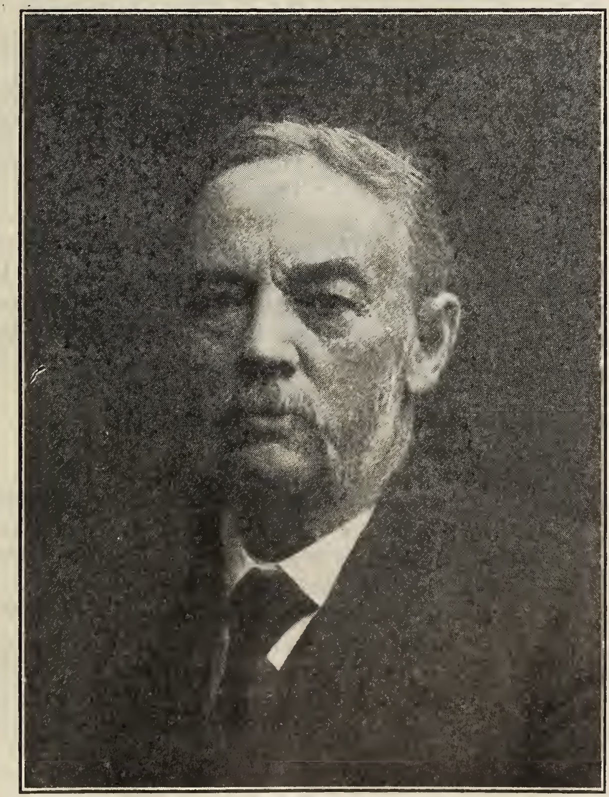
## What Have We Here?

IF the reader chance not to be a School man we beg of him to pass over the few pages which follow, for to such a one they will have no more appeal than has the Calculus to a Freshman.

You who have been initiated into the mysteries of Toike Oike will find in what follows little history and less logic. What you will find depends somewhat on you. What you may find is the spirit of the Old Red School.

What freshman is there who would not enjoy being present at a reunion of the very first "grads." of School; not a fussy, formal affair with toasts and speeches, but a pipe-smoking, feet-on-the-hearthrug occasion, with a reminiscent feeling in the air, everyone feeling free to say what he pleased about old times, and everybody , everybody else's best pal. Wouldn't the "Old Guard" themselves enjoy such a meeting? This is the atmosphere we have tried to create. We have asked a number of our early graduates to spin a few yarns. We have endeavored to make our own part simply that of the host who passes the introductions around. Apart from that we have added here and there the barest outline of facts in order to indicate the relation of the various parts.

We make no pretence at completeness. The very nature of our experiment precludes that. To those who have responded to our appeal to write something for the following pages is due all the credit for any pleasure or interest that may be derived from their perusal. These are busy men in the forefront of the engineering and business world, yet they still have interest, enthusiasm and time to spare for the Old Red School.



"JOHNNIE"

## The College of Technology.

In 1871, in a brick building on the corner of Church and Adelaide, occupied by the Mechanics' Institute, at present by the Public Library, evening classes were started for working men, in engineering subjects. The staff consisted of Mr. James Loudon (late President of the University), Instructor in Mechanics, Mr. W. H. Ellis (late Dean of the Faculty of Applied Science), Instructor in Chemistry, and Mr. W. Armstrong, C.E., Instructor in drawing.

### School of Practical Science.

During the following six years the subject of engineering education was buffeted about in the political arena until in 1877 emerged the first installment of the "Old Red School." This was the north wing, and did not include the room now used as supply department or anything farther south. When the name of the new institution was under consideration, Mr. Galbraith, in correspondence with the Minister of Education, said: "What ever you do, for Heaven's sake don't call it the School of Practical Science." The Minister's reply was in substance as follows: "I have decided to adopt your very excellent suggestion that the new institution be called the School of Practical Science." And so the School of Practical Science it was and is, in spite of recent official attempts to change it, and I suppose always will be. Because the word "School" has acquired a charm for her sons which the "Faculty of Applied Science and Engineering" can never have.

### The Red School.

When the School opened in October, 1878, the Engineering Department, under Professor Galbraith, occupied a part of the second floor of the building, viz.—a small private room, now nuber 36, a library No. 34, and a drafting room No. 33. A lecture room, now numbered 35, was shared in common with University College, while the remainder of the building was monopolised by U. C. for the Departments of Mineralogy, Geology, Biology, Botany and Chemistry. In those days, S.P.S. Students received instruction from U.C. in Mathematics, Physics, Chemistry, Mineralogy and Geology.

### Johnnie.

Now that we have seen the School established in its present home, we may well turn aside to pay tribute to a man who was the Father of the School, whose life was devoted to its service, who was at first the entire staff of the School, who was the very embodiment of the Spirit of the School. J. Galbraith, M.A., Gold Medalist in Mathematics, Professor of Engineering; to his students—"Johnnie." One has only to talk with a few of his students with whom he came into personal contact in those early days to realize what a tremendous influence he exerted over their lives. Mr. E. W. Stern, '84, speaking at the unveiling of the late Dean Galbraith's portrait, said in part:

"His (Galbraith's) technical qualifications and breadth of view were such that we soon realized we were under the guidance of a master mind. It was, however, the human quality of the man, his fineness, his way of thinking and talking straight, his kindliness and interest in each of us and his sympathetic nature, which appealed most to us. He was a man every inch of him, and one of nature's own noblemen. He never preached at us, nor did he ever talk about what was right or wrong, but somehow or other, remarkable to say we absorbed ethical teaching from him. I have spoken to many of our graduates and they all agree with me in this:—we seemed to feel what he thought was the right thing to do. We, his old pupils, are his life long friends. We owe him a debt which can never be repaid."

Mr. T. Kennard Thomson, D.Sc., grad. of '86, writes in response to our queries: "Nothing could equal the inspiration the early graduates received from Principal, afterwards Dean, Galbraith, and without any qualifications at all, that was by far and away the most outstanding feature of the Red School House."

Mr. T. R. Deacon, '91, wrote on the occasion of the Dean's death: "He has left his mark in Canada through his great influence. He was beloved and revered by every student who studied under him, and few men will be more widely mourned."

These spontaneous tributes, which could be continued almost indefinitely, require no comment, except that we quote in conclusion from Applied Science, July, 1914.

"The School will always mark the life of our late Dean in the pages of history, and if we are true to the debt which we owe him, we will not allow the growth of the School to be stunted, nor the union among School men to be weakened, but will converge our energies toward keeping bright and prominent, the monument of his building."

Dean Galbraith, besides being a scholar of most extraordinary brilliancy and versatility, was a great pioneer. When the Fenian Raid broke out in 1866, he was engaged with Mr. Stewart, Prof. L. B. Stewart's father, in surveying the North shore of Lake Superior. When the news of the war reached them, they decided that one of them should go, and to settle which it should be, they wrestled. Mr. Galbraith was the winner and crossed Georgian Bay in a birch bark canoe, but did not arrive till the raid was over.

James L. Morris, '81.

The first man to receive the Diploma of the School of Practical Science (no degrees were granted in those days) was Mr. James L. Morris. Mr. Morris, who has a large general practice in Civil Engineering in Pembroke, has been kind enough to write something for us of his undergraduate experiences, which we quote herewith:

"When a boy of about fourteen years of age, and seeing the Engineers at work on the construction of the Canada Central Railway at Pembroke, my inclinations turned towards the Engineering Profession. On making inquiries as to where an Engineering training could be secured, practising Engineers were able to give me little or no encouragement except to begin as a rod man or picket man on a Survey.

"I saw in the University of Toronto Calendar where a two year Engineering course was given and securing requirements for matriculation, managed to present myself for examination in the fall of 1878.

"In September of that same year, Alfred Baker, then Registrar of University College and Secretary of the School of Practical Science, said: 'For this two year course you will have to get your lectures the best way possible, but there is a new Engineering Course starting in that red brick building across the lawn, you had better find out about it before registering.'

"Professors Chapman, Croft, Wright and Galbraith, were the names of the staff, judging from the plates on the doors, but nothing positive could be found out about an Engineering Course until John Galbraith, Master of Arts, (Toronto), one time practising Land Surveyor near Port Hope and Assistant Mechanical Engineer for the Portland Locomotive Works, Portland, Me., and at this time the whole of the Engineering Staff, took hold of the matter himself and got the first class of the School going. That class was Clarence Galt, George S. Hodgins, Craven Ord, Gray, John McAree, and James L. Morris.

"The names of School men were prominent at the October sports of the College, in the mile, half mile, steeplechase and walking race in 1878-79 and '80. At this time all sports were held on the lawn lying between University College and the School.

"The Literary and Scientific Societies also heard from the students of the S.P.S., who listened with interest to the readings, essays and speeches of J. D. Cameron, W. T. Herridge, and R. Y. Thompon, all Arts men, for there was practically none but Arts men at that time.

"The Literary and Scientific Society passed a by-law in the winter of 1879, making all regular students of the School of Practical Science eligible for membership in it.

"As the Government did not supply any instruments for use by the S.P.S. students in 1878-79, Professor John Galbraith produced his own transit to open up the wonders of the firmament to the whole School of six. It was on the lawn, about midway between the School and the Meterological Building, which then stood on the ground immediately east of the Physics Building. It had been explained, the transit levelled, turned on polaris, the lantern lighted to illumine the cross hairs, the exact time of elongation determined, and yet thirty minutes to spare. After midnight, all was quiet, and why not leave the transit and adjourn to more comfortable quarters. Thirty minutes later there was no transit and no one in sight. A hurried council decided that it probably was in the room of a residence man. Two days afterwards a thoughtful member of the Meterological Staff, remembered that he had found a transit in the early hours, and made inquiries. It is not on record when this first observation was completed.

"At Christmas, 1880, Professor Croft retired from active work and Professor Pike took his place.

"The Easter Exams. showed that 64 out of 65 students knew nothing about Chemistry. The writer was one of the 64. With a high percentage in all other work in the 2nd Year Engineering and a prize in sight but for Chemistry. Prof. John Galbraith arranged a meeting of the Second Year in Civil Engineering, Professor Pike and himself. A special Exam. in Chemistry was held right there and then and it was declared that the text-books were to blame, and that is how one prize was given in the Engineering Department in 1880.

"From 1880 until 1886, no S.P.S. student other than a prize man ever passed in Chemistry, nor was a supplemental exacted. Looking into the Architectural Exhibit Room, in the East end of the second floor of the old School Building, I recognized the old draughting room of 1881. It did not look familiar. The old rope elevator was not there. That elevator passed and repassed through our room during lectures, and not until a Freshman of 1873, who knew all about tackle in yachts and Rugby came to the School and saw the trouble, did a solution seem probable. He walked over to the elevator, twisted the rope around a post of the rail, and then everything was quiet for a time, until the Chemical Department found out where the trouble lay and started that cry, 'The School of Science Man.'

"This was the first attempt of School men to assert themselves as part of the forces of the University."

### Jas. H. Kennedy, '82.

At this point we hand over the narrative to Mr. Jas. H. Kennedy, who is chief Engineer of the Vancouver, Victoria, and Eastern Ry., and Honorary President of the Pacific Coast Branch of the Engineering Alumni Association. Mr. Kennedy writes:

"I have your letter of the 14th inst. asking me to write something about my undergraduate experience that may be used as some help in the preparation of a story made up of fact and fiction, that will give the boys some espre de coeur or whatever you call it; now, so if I can help you with some facts you may be sure to supply the fiction, so it will form a chemical combination of gas. I presume natural gas is what you are after.

"Well the School opened in 1878, though I did not reach it until 1879. Now, I don't know how many students attended during 1878, but as near as I can recollect now, there were but two students—J. L. Morris and John McArree. There may have been others, but they must have been specials. Jimmy Morris took the full course and headed every class without difficulty. He was also quite an athlete and held his own well at the annual games against the Arts men. I think he took several prizes for running. He could run like a steer in a cornfield. The other student of 1878, Mr. McArree, was a land surveyor of more advanced years, a widower with, I think, four children. He did not return for the session of '79, but returned during 1880, and was in my class until he and I graduated together during 1882, and I have never met him since. He died in Toronto, I believe, several years ago.

"The class of '82 were Donald Jeffrey, John McArree and yours truly. There were two others who did not try the exams, David Burns, who joined a later class, and J. H. Shortt, whose principal defect was color blindness, and he had to be told the color of his ink. He never graduated so far as I know. So you see that the class of '82 was as a matter of fact the three graces, or rather the triumvirate, greater perhaps than the triumvirate that once ruled Rome, if you take into account the amount of dirt we have moved in the last forty years. Donald has stuck to contracting and I to railway engineering, and we have not been upon the some work since 1893, when we met on the Soo Line in North Dakota. Possibly this is enough along this line.

"Now I see you wish to know the spirit of the School. Well the prevailing spirit in '79 was the mischievious spirit of having fun with the Toronto police. Some students of the Arts classes went to the opera one night and returned up Yonge Street in procession and singing college songs, when the police objected. Very soon it became the habit to sing every night, and pretty soon the fashion developed of carrying quite heavy hickory canes, that kept time as they came down upon the sidewalks in time with the step and the music. Pretty soon a students' union was advocated, and the students of all colleges were advised to attend at a meeting in the old Temperance Hall on Temperance Street. Some 1200 were in attendance. Dr. Montague was called to the chair and the Students' Union was launched, with the avowed object of purchasing books at a discount. After the meeting a procession of at least 1200 formed and marched up Yonge Street, singing and wielding the canes, to Bloor Street, which was the northerly limit of the city. When all had crossed Bloor Street, the police stopped. The police did not cross the street, but lined up on the south side and the students upon the opposite side. It was then that E. P. Davis, an Arts man, now a lawyer in Vancouver, was hoisted upon the shoulders of other students to address the police, and it was done in E. P.'s best style. Regret I cannot recollect what was said, as it would be well worth remembering. Several students, I believe, were arrested upon their way home, among the Medicals, but a collection was taken up the next day and their fines paid. I do not recollect anything of the students' union after that night, and the fun with the police died out shortly after that.

"You ask for our year yell. Well, we had no yell specially fitted to our year in '79, but we shared to some extent in the general howl caused by the advent of Professor Pike to the Chair of Chemistry. Now, during the first term of '79 Professor Henry Croft lectured on Chemistry in the westerly room in the old School to students from all faculties of the University, and the dentists, veterinaries, medicals, etc. Professor Croft was a tall, slim man, who wore spectacles and whiskers and had a great reputation as a chemist, but new blood was wanted, and Professor Croft was given an address and a farewell, and Professor Pike, an English dude who had finished up in Germany, appeared in his place. Then we learned that 22.4 litres of any gas would give its molecular weight in grammes, and we never forget it. However, Professor Pike plucked every son of a gun in every faculty in the School and the University, and that is where we got the howl for all years and our '79 howl was the same. I have special personal reason for remembering that exam, as Professor Pike made a mistake and gave us a paper on other work that we had never studied, and I gave only one reply to one question. Soon after I was summoned before the authorities ties for giving an impertinent answer, which the Professor said was to be a pretty serious matter to me. However, through the good offices of our Johnny Galbraith, I was not hanged.

"Johnny was a good friend to have in those days. It is only fair to say that I now believe Professor Pike proved that he was a tower of strength to University College and to the old School.

"Well, we had no other yell during my time, and if the Toike Oike had appeared we would have taken to the tall timber no doubt.

"About that time appeared to be a transition time in the faculty of University College, as not only was Professor Croft retired, but Dr. Daniel Wilson, the president, died soon after. Sir Daniel Wilson was a renowned man in his time. A tall, slim man, who wore his high plug hat on the back of his head, wore long hair and somewhat stooped and always walked in a hurry, always reminded one of the picture of Uncle Sam. The two men who were head and shoulders above all others at that time were Dr. Wilson, and Professor George Paxton Young, who taught metaphysics, into whose classroom we often slipped very quietly for a treat. Now, if you can get anything tangible out of this you are no doubt a daisy."

For our part, we shall not try, being content with the intangible.

Prof. W. J. Loudon gives the following account of student life during this period:

"In those early days, in fact until the date of the University fire, in 1890, there were few buildings in Queen's Park devoted to education, and the western side of it, surrounding the University, was more or less of a bush, intersected by a ravine extending from Bloor Street to College Street, through which ran a little stream, The Toddle, where freshmen were baptized every Fall by their seniors. The gymnasium was merely a room in a cellar of the old Medical Building that occupied the site of the present building for Biology. Most of the students preferred a walk in the open air or a little game of association football to a turn in the gymnasium. Walking, probably, was the most popular form of amusement and exercise, being both cheap and invigorating, and the highest form of sport was a walk to Hamilton in company with congenial friends. The theatre, as it always will be, was a great attraction to the students of the period, 1878-'90, especially as that decade was a golden one in Toronto for legitimate plays, and it would take pages to give the names of the great actors and actresses who appeared during that time, and of the Shakesperian plays, comedies, melodramas and operas presented in the two theatres then existing in Toronto before audiences packed to the roof. You would be sure to see, therefore, any Friday night or Saturday matinee, groups of students scattered about the old Lyceum or Grand Opera House, waiting expectantly for the curtain to roll up—when numerous enough singing snatches of college songs, much to the delight of the audience, occasionally overstepping the bounds of propriety, always, however, ready to applaud to the echo the efforts of the great men and women who appeared on the stage.

"To the student of that day, trained in simple habits, without the phonograph, movies, automobile, when even the electric light and telephone were luxuries, such a treat as a Shakesperian play constituted a great privilege and was a real education. There was no residence for Science students, the existing one, which formed the western wing of the Main Building, being used only for students in Arts. But board and lodging were easily obtained and prices were low, from two to three dollars a week being the average charge. There was practically no supervision of the student; he did what he liked as long as he attended a good proportion of his lectures. Sometimes this was a bad thing—usually a good thing, as it encouraged independence and self-control.

"Comparisons are odious and it would be futile yet to compare the past with the present; but one feature of the daily life of the student of bygone days stands out in bold relieef, namely, the personal contact with his fellow-students and teachers; they all knew one another, not casually, but intimately; inquiry was encouraged as well as interchange of opinions. So that very slowly, but surely, there was laid in each student's mind the foundation of that which is more important even than education—personal charactere."

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### G. H. Duggan, '83.

The only graduate of '83 with whom we were able to get into touch was Mr. G. H. Duggan, D.Sc., President and Chief Engineer of the Dominion Bridge Co. Mr. Duggan writes as follows:

"I am in receipt of your letter of February 9th, and sympathize with your campaign to keep the traditions of the School before those who now have, or who have had, the privilege of falling under those traditions.

"I am trying hard to straighten out my affairs so that I may leave the end of this week for a month's cruise in the Caribbean, and regret that, in consequence, I shall be unable to assist in your work. The only consolation is that those of the very early years were too few in number to have made any traditions for the School or to have much to recount that would be of interest. If my memory serves me correctly, only three graduated in our year and our School life was of necessity mingled with the other faculties of University College."

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### E. W. Stern, '84.

Having tried to get into touch with Mr. E. W. Stern, '84, and failed, we take the liberty of quoting from his address on the occasion of the unveiling of Dean Galbraith's portrait:

"It was then (1881) a very modest school, only three students in the third year, three or four in the second, and about one dozen of us freshmen. The faculty in engineering consisted of Prof. Chapman, Dr. Ellis, Dr. Pike, and Prof. Galbraith, and we had a few hours a week in University College under Profs. Loudon and Baker. All the engineering lectures were given by Prof. Galbraith, as well as the field instruction in surveying, and for three only too short happy years, he led us all the way through the mysteries of mechanics, thermodynamics, descriptive geometry, hydraulics, etc.

"He was not only popular with us, his students, but he was appreciated by all sorts and conditions of men. The Ojibwa Indians call him by a name which means 'The Little Chief with the noonday face.' I recall personally a suggestive incident bearing on this phase of him. Twenty-six years ago, during my summer vacation, I was on a surveying party in Nipissing; one night our party were encapmed neear a Hudson's Bay post called Fort McLeod, at the mouth of Sturgeon River. In talking with the factor, whose name I cannot just now recall, he asked

Dean Galbraith Camping with Indian Guides.

if I knew a little professor from Toronto—John Galbraith by name. I told him that I did know him and that I was then studying under him. He said to me: "he is the finest man I have ever met; he tells the best stories,—I would like him to visit here again," and we drank the professor's health from a black bottle and, thanks to him, I slept in a bed that night, the first in four months.

"There were five of us who graduated in the class of 1884, a striking contrast with present times. I shall never forget his farewell address. Calling us together, he told us that now having completed our course at the School, we must start in the world with the idea in our minds that we knew nothing whatever about engineering, and should commence our practical work at the bottom. It was characteristic of the man's modesty and thoroughness; never was better advice given, for we started out in the world with no false notions of our importance, and worked our way up gradually without friction."

"Those of our younger graduates whom I have met in recent years as well as the older ones, have nearly all appeared to me as having some certain characteristics in common, namely, thoroughness and modesty. I know of none who have been failures in life."

## The Engineering Society.

The year 1885 may be marked without fear of contradiction as being the red letter year in the history of undergraduate life in the School, for it was in this year that the Engineering Society came into being. We are very fortunate in having the story from the father of the Engineering Society, Dr. T. Kennard Thomson, who is now a consulting engineer in New York city. This is what Dr. Thomson says:

"In 1885 the late Herbert J. Bowman suggested that the S. P. S. boys should have an exhibition at the annual University Conversazione, so we got together and rigged up an Engineers' Camp with transits, levels and other implements of scientific labor, artistically arranged outside. The Camp was made realistic by means of some pine trees, and plenty of cotton batten for snow, to say nothing of a dummy made by artistically stuffing

T. Kennard Thomson.

straw into an old suit of my corduroys, which dummy made a great impression on the lady visitors from the pathetic manner in which he was reading a letter from home while reclining on the ground.

"I have never heard whether this camp feature was ever repeated or not.

"About that time, I suggested forming an engineering society, but was told that the third year men had taken the matter up very carefully the year before and had finally decided that it would be absolutely impossible to start such an organization in such a young school.

"So I apparently dropped the subject for a few weeks, but being young and ignorant, did not realize that as there were at that time only twelve graduates of the School, that of those who were at college only sixteen would graduate, the time was hardly ripe for such an undertaking. So I invited Principal Galbraith and Dr. Ellis and the entire class of 1885 and 1886 to take dinner with me about three weeks later. To enliven the meeting I also invited the now eminent Attorney David T. Symons of Toronto, and my old red-haired room-mate of Upper Canada College days, whom I knew as 'Gooie,' but who was the eminent Dr. James D. Thorburn when he died some years ago.

"Incidentally I have never known a red-haired man or woman who was not amply supplied with brains and energy and humor, and J. D. T. was no exception to this rule.

"After the coffee I gave my guests the first intimation as to why I had taken the liberty of inviting them to the house of my sisters and myself, by getting up and suggesting that we co-operate and organize an engineering society. Fortunately Principal Galbraith, who had so kindly accepted the invitation, with his unfailing kindness of heart, at once got up and made a speech which ensured the success of the entire project. A committee was at once formed to draw up a constitution.

"It is true that the society has had its ups and downs, but its recuperation from a few setbacks and marvellous step forward in each case has been a source of unfailing pleasure and gratification to me, as it is always a pleasure to start something going and see each successive leader going farther than his predecessors.

"In the early days we did not dare risk anybody but Principal Galbraith for President, but he finally insisted upon retiring when he was able to turn over the reins to such a capable successor as Haultain, now the distinguished professor.

"It would be hard for me to find anything in the engineering line which I am so proud of as I am of my connection with our Engineering Society. You will notice the only qualification I put in the above sentence was in the two words 'Engineering line,' and you will understand this qualification when I remind you that I married a Toronto girl and have five children."

The organization committee was as follows:—

President—Prof. J. Galbraith.
Secretary—T. Kennard Thomson.
3rd year rep.—B. A. Ludgate.
2nd year rep.—J. R. Gordon.
1st year rep.—J. C. Burns.

We continue to quote from Dr. Thomson's letter.

"In answer to your question as to why the class of 1886 surpassed that of any other year, I say that it was because A. M. Bowman, E. B. Herman, Robert Laird and Henry Gratton Tyrrell were the brainiest and finest bunch of boys (they have lived up to their reputation ever since) that was ever turned out of any school. But I would like to apply the same remarks to all the graduates and special students from J. L. Morris of 1881 to Professor C. H. C. Wright of 1888, as there are only two in all that number whom I have never met. I had frequent correspondence with those two as well as all who graduated before me.

"Not having known all the men of the later years, there may or may not have been an occasional "lemon" in each year, but I am ready to contend with anyone that there were no "lemons" among those who graduated before me or were at college at my time, and I have kept track of most of them ever since.

"I remember that one of my classmates, who had spent a marvellous summer surveying on the prairies, fell asleep during a mathematical lecture. Of course Professor Baker realized that no one could fall asleep during his illuminating lectures, and when he saw my classmate's head drop forward, realized that he had fainted, and asked me to escort him to his boarding house, which I did with pleasure. By the time I walked to the other side of Yonge Street, he had quite recovered from the change of air and diet.

"Once I walked up Queen's Street Avenue, now University Avenue, with one of my classmates, when a young girl ran up from behind, gave him a hard slap in the face, and then disappeared. This struck him so funny that he stopped in the middle of the sidewalk and laughed until he nearly had hysterics before I could get him to move on.

"In my time there were so few of us and we were all such hard workers that we had no time for anything, excepting a few scraps with the Medicals. Nor did we have the time or brains to invent a yell, and the first time I had the great pleasure of hearing the 'Toike Oike' was after a lecture before the Engineering Society of McGill University, when they honored me with a real 'Toike Oike' yell in great shape."

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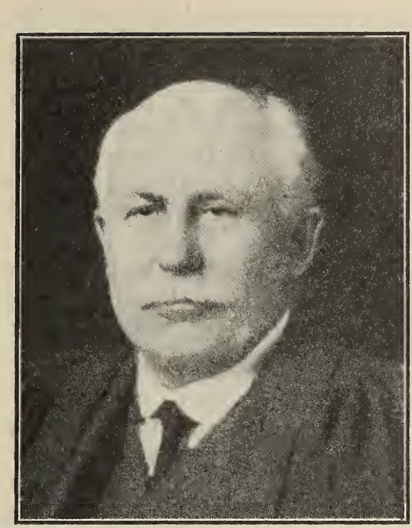
THE first publication of the Engineering Society appeared in the year 1887. It consisted of a forty-three page booklet containing seven papers read before the Society, mostly by undergraduates, during the session 1885-86. The publication of these papers was continued annually until 1908, when "Applied Science" put in its first appearance.

We happen to have a prize list of the year '88 in which we note with interest that the name at the top in twelve subjects out of fifteen, is C. H. C. Wright. The three subjects in which he had to be content with second or third place were chemistry, mineralogy, and essay. In the second year T. R. Rosebrugh headed the list in every subject in which he was a candidate, with one exception. In the column headed drawing, T. R. Rosebrugh appears, sad to relate, at the wrong end of the list. We are very sorry that Prof. Rosebrugh's health has necessitated his going south for the winter, and consequently we have been unable to approach him on the subject of his undergraduate reminiscences. Prof. Rosebrugh was appointed to the staff in 1890, being the third appointee in the Department of Engineering. It is our sincere wish that he may be with us again during the coming session, fully restored in health.

During the session 1887-8 the general committee of the Engineering Society was as follows:

President—Prof. Galbraith.
Vice-President—C. H. C. Wright.
Secretary-Treasurer—H. E. T. Haultain.
Corresponding Secretary—G. H. Richardson.



C. H. C. Wright.

PROF. C. H. C. Wright has continued all his life in the front rank of all School activities—academic, athletic, political, Y.M.C.A., social, military—and if we have omitted to mention any fields of endeavor connected with the School, no doubt he has been foremost in them too. We hope that in the future he may find time to put in writing some of his intensely interesting memories of School, and for the present we are indebted to him for the stirring description which follows, of student life during his undergraduate days.

### Early Initiations.

"It was an established custom within the University for a special committee of the senior students during the first two weeks of the session, to investigate many suggestions and conclude in most cases that the member of the first year was too fresh and must be arrested and brought before the "Mufti." On the appointed afternoon the royal guards seized the victims and locked them up in some obscure room in the basement of the S.P.S. or W.C. About ten o'clock a procession of students was formed up and proceeded on a tour of inspection of the grounds, led by the "Mufti," the Council and the guards with their prisoners blindfolded. Everything proving satisfactory, the "Mufti" ascended the throne on the terrace near the main tower and, surrounded by his Council, proceeded to try the various prisoners. They were sworn in by the bones of Sir Daniel Wilson (President of the U. of T.), and at the close of the trial took a solemn oath to treat all senior students with respect, to abstain from wearing gloves, or hard hats, carrying canes, etc., and generally to assume a humble attitude. Every prisoner was furnished with legal advisers (senior students), who might plead anything from a head bursting with the ability of genius to insanity. In such cases the Meds would be called in to examine the head in question and report. After a most thorough examination with running comments, a conclusion would be arrived at such as: "I find here, sir, a well balanced head, nothing in front and nothing behind." Thus from start to finish (usually daylight), the meeting would be punctuated by roars of laughter.

"If the prisoner failed to answer the questions to the satisfaction of the Council or to humble himself as becometh a freshman —"an insect"—"it," etc., some form of torture would be applied and might range anywhere from the shaving of part of his moustache, to a trip down the River Toddle on his back.

"During the Autumn of 1885, a freshman by the name of Coil was locked in the basement of the School in preparation for the hazing ceremony. When things became quiet and the guard small he, having found an axe, smashed his way to freedom, taking care to help all others similarly situated, and at the same time do all the damage possible in a short time. The following day this could not be overlooked and as a consequence the caretaker was dismissed and "Prof." Graham appointed in his stead.

### Elections.

"There were interesting elections in those days, but they were those of the Arts Society, i.e., the Literary and Scientific Society, in which S.P.S. regular students were eligible for membership. Most School men, however, were satisfied that the Engineering Society was sufficient, and did not join during the session. They were then the legitimate prey for the corruption committees of the two Lit parties. They were invited to attend the annual elecions and were usually driven in a cab to the hall. There they were met by the two brute force committees (Varsity athletes), stripped to the waist and kept covered with vaseline, whose duty it was to pass the candidate on to the polling booth or keep him out, according to instructions. The Lit regulations provided for the closing of the poll as soon as five minutes passed without a vote being polled, thus during the early part of the evening it usually required four minutes for a candidate to pass the B. F. committee and be pushed through the door to appear before the returning officer. Here every School man was required to undergo an examination and answer such questions as: Your name? Factulty? Who is Johnnie? Who lectures to you in Math.? What does Alfie look like? What does he think about S.P.S. students? Are you a member of the Lit? If not a member then how did you get here? One of the scrutineers would then hand the Treasurer of the Lit the fee ($1.00) from the corruption fund of the proper party and proceed to mark the ballot, thus saving the candidate any further trouble. Then came the refreshment room, with its tables burdened with crackers, cheese and beer, and other liquids.

"In 1878, when John Galbraith assumed his dutiese as Professor of Engineering in the Old Red School House, he was disappointed that there was neither equipment nor even accommodation for any engineering laboratories in the new building recently erected by the Government for the School of Practical Science. For ten years, while struggling hard with all the engineering subjects of all years on the calendar, developing and delivering the various courses of lectures, he continued to point out to the Hon. the Minister of Education (G. W. Ross), that if he ever expected to develop the Province of Ontario he must provide the means for educating the coming generations of engineers. At last, in 1888, Prof. Galbraith was requested to accompany Dr. Ross on a visit to the Engineering Schools across the line. The result of this visit was the erection of the southern portion of the present Engineering Building and the equipping of its laboratories on a scale that was then considered very liberal.

"Thus in 1890 with the new building containing modern engineering laboratories, with an enlarged staff and the control of the institution entrusted to a council composed of the S. P. S. staff, the School made a fresh start towards an ever widening field of usefulness. Prof. Galbraith, now Principal Galbraith, appreciated this reward of his untiring efforts, and with this stimulus immediately mapped out for himself and his staff newer, broader, and higher standards that his School and his boys might be acknowledged as good as any, if not a little better.

"Research work in Canadian materials and the methods of their uses was encouraged and started as soon as the equipment in the various laboratories was installed. Thorough investigations comparing the values of Canadian and imported building materials and products were started. As a direct result of these researches the engineering and architectural professions were furnished with many constants that enabled them to use Canadian goods intelligently. The Toronto press was naturally interested in these practical tests, and published many readable descriptions of the work of "Johnnie" and his laboratories. Thus not only the profession but the public gradually gained a confidence in our locally manufactured building materials that has not been shaken since.

"It was not long until the Government of Ontario was fully satisfied that the money spent on the S. P. S. was a good investment for whenever they or any municipality or private organization in the Province had a difficult engineering problem, there were sons of Ontario equipped and ready to solve it. Not only then was "Johnnie" proud of his boys, but the Hon. the Minister of Education and the Premier of Ontario were too.

"Thus during the first twenty years of the School's struggles for recognition, the students and their engineering society, the staff and council with "Johnnie" as a leader, fought hard, shoulder to shoulder, and it is no wonder that there grew up a bond of union, a fraternal spirit that has lasted and will last as long as time. "Service, Truth and Honor" was his motto, and while he never published it, he lived the part and expected the School to act accordingly, with the result that the banner of the institution, untarnished, is carried high by a large number of distinguished graduates from coast to coast and even to the uttermost parts of the earth. Today the sun never sets on the Little Red School House.

"When the hinterland of Ontario had to be explored, S.P.S. men were ready to stake out the lots or claims—ready to build lines of communication—ready to push the frontier back to make it more habitable and increase its output—ready to burrow beneath its surface and bring its treasures to light, and ready to utilize its water powers. Finally, they have solved the old riddle, "What would happen if an irresistible force met an immovable body?" Have not the stalwart sons of the School harnessed the irresistible Niagara and distributed its blessings of power, light and heat to the multitude living in Southern Ontario?"

IN the year 1888 a radical departure was made in that the Engineering Society had a student president for the first time. The general committee was now made up as follows:

Pres.—H. E. T. Haultain

Vice-Pres.—T. R. Rosebrugh

Sec.-Treas.—J. Eaman

Cor.-Secretary—F. X. Mill

—all undergraduates at the time.

Prof, Haultain says:

"'Johnnie' always insisted that the Society should be run entirely by the students. 'Johnie's' advice to us was: 'Run the Engineering Society yourselves.' When that principle has been departed from generally there has been trouble."

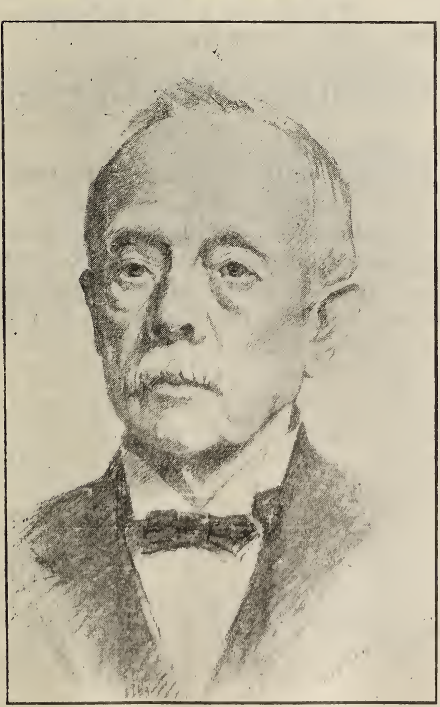
H. E. T. Haltain

Prof. Haultain was a freshman in '86. He says the prevailing form of initiation for freshmen in those days was to bring them up before a court for trial, each individual case being tried strictly on its merits. This method of initiation seems to have dropped out of use about 1888. Tapping was quite a regular form of punishment. The second and third years used the same drafting room. The bill for window breakage in that room during one term was $58. This is striking evidence of the fact that even at this early period, class spirit had reached a high state of perfection.

Prof. Haultain started a library for the Engineering Society, to which volumes of engineering publications were contributed by Col. Gzowski. The first volume to be bought out of Engineering Society funds was Rankin's "Civil Engineering." The fact was brought out very strongly by Prof. Haultain that the late Dean Galbraith was the dominating influence in the early days of the School.

A very picturesque figure at the School at this time was "Prof." Graham. "Prof." Graham was appointed caretaker in the Autumn of 1885. He made drafting boards, which he sold to the students, and every night at the appointed hour he uttered the momentous dictum, "five o'clock, gentlemen." It was the custom for the students to give him a Christmas present, and on one such occasion he was presented with a greased pig, which he was forced to pursue through the building for some time, much to the amusement of the onlookers.

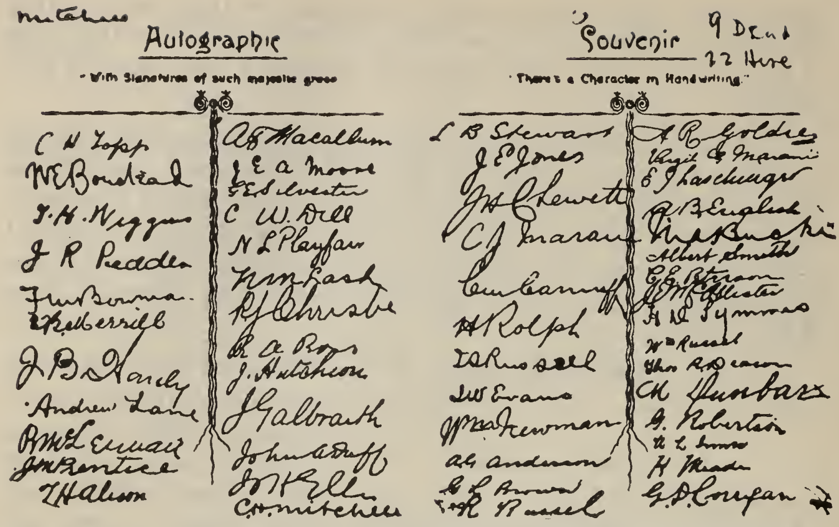
**"5 O'Clock, Gentlemen."**



**Prof. Graham**

The first dinner of the Engineering Society was held at the Hub on Jan. 31st, 1890. A grand total of 54 assembled, and among them was Dean Mitchell, who was the freshmen's representative on the executive.

We reproduce an autographed menu used on this occasion. The signatures of most of the undergraduates and some of the graduates will be found on it.



Autographic Souvenir

"With Signatures of such majestic grace"

"There's a Character in Handwriting."

9 Dead
22 Here

C H Topp
W E Boustead
T. H. Wiggins
J R Pedden
J W Bowman
J B Hardy
Andrew Lane
T H Alison

A B Macallum
J E A Moore
F E Silvester
C W Dill
N L Playfair
R A Ross
J. Hutcheson
J Galbraith
John A Duff
C H Mitchell

L B Stewart
J E Jones
C J Marani
H Rolph
T A Russell
J W Evans
Wm Newman
A G Anderson
G L Brown

A R Goldie
Virgil G Marani
E J Laschinger
A B English
Albert Smith
Wm Russel
C H Dunbar
A. Robertson
H Meade
G. D. Corrigan

Mr. R. A. Ross, E.E., of Montreal, has written us, in response to our appeal, as follows:

**R. A. Ross, '90.**

"Yours of January 14th and 24th, with reference to memories of Undergraduate Days, has been causing me a lot of worry. I am sorry to say I have few recollections of those days except those involved in hard work; and, looking back, I cannot help feeling that my year, including myself, was a rather uninspired and uninspiring bunch. We had no time for frivolities like the Arts men; and a more drab existence from the point of view of literature it would be hard to find. My own recollection is of the freedom I used to feel at 8 o'clock in the morning when, waking up, I realized that I only had to spend the rest of the day in listening to lectures, drafting and studying, which, as compared with the previous existence of four years of apprenticeship, a part of which time was spent in wheeling cordwood (extracted from the neighboring snow-bank) for the voracious shop stove, oiling shafting, scrunting castings, carrying off iron on casting days for the moulders, and learning profanity from the boiler makers while holding on, constituted a contrast which was the nearest thing to heaven which I expect to attain to, at least during this mortal life.

"I judge from the remarks of Walter J. Francis and others that I was looked upon as a very serious young man, and more fitted for the undertaking business than anything else; and that seriousness of mine still afflicts me upon occasions yet, so that the lighter and more joyous aspects of student life are absent from my recollection. Also, I was at a dinner last night in Montreal."

We regret that we had no opportunity of interviewing Mr. Ross during dinner, but we feel confident that if he could be approached at exactly the right moment he would favor us with a more optimistic message.

In the fall of 1890 the southern wing of the Red School was completed and occupied. We gather from the address of the president of the Engineering Society (1890-91), the late Mr. J. K. Robinson, that the School was now established on a scale of unprecedented grandure. Mr. Robinson said:

### J. K. Robinson, '91.

"We who have worked through the last few terms of this School, in the overcrowded and unventilated condition of its rooms, may and do congratulate one another on the possession of such rooms as we now have, combining as they do good light, good ventilation, good heating, convenience, taste and a spaciousness that will more than accommodate the old students, and the fifty-three new ones that have come among us,"

Further, Mr. Robinson's modesty bade him say:

"Perhaps none that graduate from this School will ever rise to the height of his profession, and surprise the world with his skill. But who knows? It is not impossible. One thing is necessary—thoroughness."

We learn also from this address that Mr. H. E. T. Haultain, "an able and pushing young man," was at this time chief engineer of a tin mine in Bohemia.

The vice-president of the Engineering Society at this time was Mr. T. R. Deacon, now president of the Manitoba Bridge and Iron Works, Limited, and ex-Mayor of Winnipeg. Mr. Deacon writes us as follows:

### T. R. Deacon, '91.

"I duly received your letter of the 14th inst., re reminiscences of the Old Red School. I have delayed replying, hoping that I would find myself in a proper frame of mind to write something interesting, but so far the inspiration has not come.

"It will be thirty-one years this Spring since my class left the School, but in many respects it is as fresh as yesterday in my mind and does not seem more than a year or so ago. So far as I know there are only five of our class living, although there may be more, and George E. Silvester is one of them. He was by several years the youngest member of the class. We certainly had some stirring times, but I am not going to deal with that in this letter. I will try and prepare something when I feel in the right spirit.

"I am thankful to say we had no college yell, which I have always regarded as an extremely silly schoolboy proposition, and I am satisfied that older people frequently stay away from entertainments and receptions, etc., given by students, rather than submit to the discordant noise of a lot of kids yelling.

"Inasmuch as all the courses were combined in our day—Sanitary, Civil, Mining Engineering and Surveying, we had to work like "Sam Hill." Our class wrote on 21 subjects the first year, and it was the class of '91 who started a sort of insurrection or protest against this overloading and put in a strong petition backed by other influences to have the course split up and lengthened. In those days most of the classes were older than they are now, the average age probably being 22, although there were some up to 35, and George Silvester was only 16 or 17.

"It was in February, 1890, I think, that the University building was burned down, and I think I was the last student in the building before the fire occurred. It was the evening of the annual Conversat, and I had agreed to remain to look after the things we had on exhibition until some of the others came back. However, the caretaker came along and told me it was not necessary for me to remain as he would shut the iron gates at the front. University College was then lighted by coal oil lamps only, and shortly after I left the building two men carrying a tray of coal oil lamps which they had trimmed in the basement, fell on the main stairs and set the whole place on fire. The nearest hydrant was 1400 feet away, and the water pressure was barely sufficient to throw water into the windows of the first storey, and perhaps 10,000 people stood around, many of them in dress suits and dancing pumps, and helplessly watched the building burn down.

"We had borrowed a great many things to decorate the building, including thousands of dollars worth of special hot-house flowers, and nearly all the large flags that were in Toronto at that time. Of course, these were all burned up, and there was the dickens to pay. As nobody had any money in those days, some of the members of the Finance Committee who had negotiated for the loan of these things were obliged to take to the back townships for a few weeks till the thing blew over. Some hastily changed their names temporarily.

"As some of the University College professors who were there then are still there, and old men, no doubt full of dignity, some of the anecdotes which might truthfully be told about them in their younger days would never do now. For instance, one very solemn gentleman lecturer used not infrequently to arrive at the lecture room showing unmistakable signs of a recent 'jag.'

"Many of the men of the years '92, '93 and '94 will doubtless remember the boxing bouts every Friday evening in the room under the Engineering Supply Room of the old Red School, between the writer and Mark Dunbar (now dead). One weighed 177 pounds, the other 178; each 5′ 11½″ tall, and each in their 24th or 25th year; both country-bred boys and the best pals in the School. The whole school practically used to assemble, standing on benches around the wall, and watch us go to it until one went down. There never was any certainty which this would be, as it was only a question of a vulnerable spot left unguarded for a fraction of a second, and one of us would be on the floor. There never was any ill humor, no regrets and no sympathies wasted.

"Most of the students had a wholesome respect for Prof. Galbraith as a disciplinarian, although as a teacher we often thought his processes difficult to follow. Everybody loved dear old Dr. Ellis and had many a hearty laugh over his mathematical embarrassments.

"In those days the classes were small, but at least among the boys from the country there existed a great spirit of camaradrie, and one could borrow anything from a pipeful of tobacco to a dress shirt if anybody in the class had one. I think it is fair to say that in sports and athletic events, and even in the inter-faculty debates, the School held a place in the honor lists out of all proportion to its numbers, and always gave a good account of itself. I believe that it fully maintained this reputation in the Great War. School-men should pull together and not try to destroy one another in the great battle of life afterwards."

The name of Mr. Deacon's eldest son, Lieut. L. J. Deacon, '18, appears in our Roll of Honor.

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To Mr. Silvester, '91, we are indebted for the many interesting facts and anecdotes which follow:

### G. E. Silvester, '91.

'Ninety-one as a freshman year was composed of around thirty-five, about eleven graduating. At that time there were two sets of examinations, one at Christmas and one in April, each covering the preceding term's work. This practice was abolished about 1889-90.

The President of the University was Sir Daniel Wilson, who was a very dignified old man, very much revered by all, well-liked by the students, for he understood them and allowed many events to pass apparently unnoticed, which with some men would have caused considerable trouble.

At that time many lectures were taken at U. C., and some of the Arts men took Chemistry at the School of Science. Prof. Chapman, who was as well versed in Greek and Latin as in English, was lecturer in Geology and Mineralogy. About Mr. Silvester's last year, lady students began taking lectures at S. P. S., and some were taking from Chapman. Chapman as a rule began his lectures with a few odd stories, which were a bit off-color for a mixed class. However, it always took the ladies five or ten minutes to get around to his lectures from the Arts building, which enabled him to get away with a few before their arrival. Many a time, though, he had to cut them short. Nicknamed "Chappie," Galbraith known as Johnny, Ellis as "Doc," and Baker as "Alfie."

A big evening in the college year was Hallowe'en. This usually took the form of a theatre night, with a monster parade, etc. The old Grand Opera House was always jammed to capacity. The women's residences were serenaded and the Toronto police force, which at that time was very inadequate, was given a rough evening.

The stage stars in Mr. Silvester's day were Rose Coughlan, Sol-Smith Russell, Joe Murphy and Lilly Langtry. The Prince George was the leading hotel and most of the well-known actresses stayed there. Rose was a great favorite with the University boys. After the show, on this special night, they unharnessed the horses from the immense carriage, which was waiting to take her to the hotel, and about a hundred of them dragged it to the Prince George, up the steps into the rotunda, and to the foot of the main stairway and carried her upstairs to her room.

Annual elections of the Literary Society was another big event. There was at that time what was termed a "Brute Force Committee" representing each side—the inside party and the outside party. Naturally, the oldest clothes available were worn on those occasions. Each voter had to run the gauntlet of the "Brute Force Committee," and when the poll was reached, he was as a rule hardly able to vote. Usually some old building on Queen Street West was hired for these rough-houses.

The old traditionary feud between Arts and Meds. existed—no one seemed to know how it began. The three faculties (Arts, Meds., Science) took some lectures together in the circular west room of the main building. The result was that accommodation was very scarce and the first ones in were the winners, it developing into a free-for-all fight when the Meds. (who were perhaps a few minutes behind time) arrived. Arts formed a sort of a "Secret Service," and when Meds. were expected in large numbers an S.O.S. would be sent in to School, who at that time were backing up Arts. The Prof. in charge would look up Sir Daniel, and this worthy old man would appear and attempt to quell the uproar. Mr. Silvester mentioned the fact that School were always the "shock troops" of Arts. After a fight the place would be littered with hats, coats and other torn wearing apparel.

The campus was fenced in in those days, and the University did its own policing. The city police had no jurisdiction over the students when on University property, and this fact was taken advantage of many times, to the odd passing policeman's discomfort. The regulation stunt for quelling the spirit of an unruly freshman was to paint him over with red and black inks and tap him. Transoms were also turned up in a horizontal position and filled with water, a string being attached to them and the door, which resulted in a gallon or so of water pouring down on the first person who entered.

The football star was **Harry Senkler,** and **"Matty" Thompson** was also well-known—Association, not Rugby football.

"Bob-tailed" cars were being used on College Street in Mr. Silvester's day—very light cars, not unlike the trailers used here now, but pulled by a single horse. There was only a driver, no conductor, to collect the fares, which were passed from one person to another up to the driver. One of the stunts in vogue was to rush down and board a car at the rear and put on the brakes, thus preventing the horse from moving the bus. Then, while the driver was around loosening the brakes, the boys would unharness the horse and chase it away. When this was accomplished, several would go to each end of the car and lift it off the tracks.

The Hon. the Minister of Education (G. W. Ross) said he didn't like the appearance of a high wooden fence which encompassed the old Normal School, so the boys formed up around it on a certain evening, and, at a pre-arranged signal (a bugle call), rushed it in a body and the entire wall collapsed "like the walls of Jericho"—and with a half squad of policemen in the vicinity, looking on aghast.

Principal streets for students' boarding houses were McCaul, Boon, Church and Henry. Average rates were $3.00 per week for board and room. A few of the wealthier students lived in very exclusive residences at about $5.00 per week. The only students' restaurant was on the south side of College, just west of Spadina. Two large stores there were taken over and turned into an eating place, and meal tickets were sold to students. This was run by the proprietor of the present Waverley Hotel.

Concrete in those days was used very little and reinforced concrete practically unknown.

## Postcript

Those twin tyrants, Time and Space, bid us interrupt the discussion at this point. We say "interrupt" rather than "terminate," because we hope to meet again when Transactions is published next year, and that on that occasion graduates of the more recent years will join in the discussion. It may be that this beginning will stimulate alumni of all years to commit their impressions and memories of the School to writing before they become too hazy or altogether lost.

## Acknowledgments

In addition to those whose names appear above as direct contributors, we wish to thank the following, who have helped us materially in the preparation of these pages: Mr. J. S. Galbraith, Sir Frederick Stupart, Prof. C. H. C. Wright, Prof. H. E. T. Haultain.

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**SOCIETY**

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# Transactions and Year Book

OF

## The University of Toronto Engineering Society

WITH WHICH IS INCORPORATED "APPLIED SCIENCE"

PUBLISHED ANNUALLY BY THE SOCIETY

No. 35 TORONTO, APRIL 15, 1922 Price 50c

C. J. W. McKeown............................*Editor*

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## EDITORIAL

To its many friends and members, the Engineering Society once more presents its, now annual, publication. It is hoped that the papers which this issue contains will prove useful as well as interesting. As will be seen, the members of the staff have made no small contributions to the fore part of the book. For their very willing and generous contributions we wish to thank them most sincerely. Then, the list of names appearing at the first will ever remind School men of the place they must occupy, if they would be worthy of these who have gone before. But men like these have gone out from School ever since the first man graduated. A desire to preserve as many of the early traditions as possible and to see more School spirit in future classes, has led us to commence what one might call a history. The Assistant Editor spent much time and work on collecting material from a great many sources for this history. He feels that it will help in achieving the desired result and leaves to his successor the task of contributing another chapter on the life of a great institution.

·EXECUTIVE:–UNIVERSITY·OF·TORONTO·ENGINEERING·SOCIETY·
·1921–1922·

## RETIRING PRESIDENT'S ADDRESS.

THE time has come when we must hand over our responsibilities to our successors. At such time it is customary to make some review of the activities of the year. The details connected with our various functions are thoroughly covered elsewhere in this publication, so I shall confine myself to a few generalities.

The year that has just closed has not been marked by any outstanding occurrence. Most of our activities have followed the line of well established precedent. The freshman rules as instituted last Fall, were a new departure. The idea was first carried out in our Faculty and in a short time spread to nearly all parts of the University. It has received some severe criticism and also favorable comment. Whether or not they should be put in force next Fall should rest with the incoming second year. Having been through the mill themselves they should know whether the reasons which are given in their favor are all that they are claimed to be.

Our Annual Dinner was held in the Fall and although the attendance was not large, I think it was a success and I hope that those who attended, enjoyed it. It has been seriously proposed that this function should be dropped, and the reason given is that the majority of the members of the Society do not support it. This is true enough, and the atttendance this year was less than that of the year before. It must be remembered, however, that the Dinner is almost as old as the Society itself, and so long as a reasonable number are interested it should be continued.

Following the lead of last year, Spasms was again put on in Massey Hall. It was a success in every phase except the financial. It is very evident that this activity does not receive the support it deserves, and it is open to question whether it should be continued. Perhaps the difficulty could be overcome by making it of more local interest and holding it in Convocation Hall or Hart House Theatre.

Undoubtedly the attendance at both the Dinner and Spasms was affected by the dates on which they were held. They were less than a week apart and came in a period crowded with other University activities. It should be explained that when the time for these two affairs was being considered, at the beginning of the term, it was decided to hold them both in the Fall, if at all possible. The rush of events in the Spring term is phenomenal and we felt that the less left to that period the better. The two dates selected were the best obainable.

Another thing that should be mentioned was our part in the Graduates' Reunion. The officers of the Engineering Alumni

Association rightly look to the Society for considerable help in the details connected with such a reunion. We appointed a committee to co-operate with the various committees of the Reunion and to render assistance wherever possible. This consisted mainly in getting the registration, selling tickets, and making returns for the secretary.

During the Christmas holidays we had the University superintendent put in numerous shelves and a table which were needed for the more efficient working of the office.

The main feature of the second term was the dance. As the space in Hart House is limited we were unable to accommodate all those who wished to attend. A great deal of time was given by the committee to make this dance a success and I think that it lived up to the reputation that has been established for the Science At-Home.

There have been perhaps fewer general meetings of the Society this year than for some considerable time. This was because of the general policy, adopted early in the first term, that a meeting should be called whenever we were able to secure a speaker with a subject of general interest to all members. This has been no easy task as such people are always extremely busy. In more than one instance, pressure of business forced the withdrawal of a promise made earlier in the season.

As the Supply Department is not being mentioned elsewhere, I would say a few words concerning it. During the past two years a business has been developed in Room 19, the magnitude of which is only realized by those in close touch with it. Because of the revenue obtained from it and the attention that must be given to its management, the Supply Department is the most important of the undertakings of the Society. Since the war the volume of business has steadily increased until now it is as large as can be handled by an undergraduate student. Any further expansions should be considered from that viewpoint. The balance sheet, published elsewhere, shows the result of this year's turnover. The profits are the largest for any year in the history of the department. Such a profit is not necessary and the executive has given considerable thought as to what should be done with it. A reduction in the price of articles could well be made, but it must be remembered in doing this that the general expenses of the Society, due to its many and varied activities, are not covered by the fees, and that a good deal must be made up by the profits of the department.

In closing, I wish to thank all those who have taken an active part in the affairs of the Society. No executive could have been more willing to assume responsibility or done so with better effect. Any success we have had is due mainly to their efforts. I wish the new Committee every success and feel sure that under their direction the prosperity of the Society is assured.

J. A. LANGFORD, President.

## INDUSTRIAL CHEMICAL CLUB.

As a result of the recent sudden increase in registration in Chemical Engineering, that department has become one of the most important ones in the Faculty. There are now over one hundred and fifty members of the Chemical Club, about ten times the number there were ten years ago.

Together with this increased registration there has been a slight tendency toward lack of interest of the members, due chiefly to the unwieldy character of the club. It was the endeavor at the beginning of this term to stimulate the interest taken in the club in three ways. The first was to have at least two of the old-time dinners. The second was that of giving the members of the club an opportunity of delivering addresses, as well as hearing papers furnished by outsiders; and the third, to generalize, if possible, the subjects of discussion at the dinners and smokers.

The year was begun with the following executive: Hon. Pres., Prof. J. W. Bain; Hon. Vice-Pres., Dr. M. C. Boswell; Pres., A. E. H. Fair; Vice-Pres., L. M. Price; Sec.-Treas., H. N. Baker; Curator, V. B. Lillie; Year Reps., 4th Year, H. M. Dignam; 3rd Year, E. H. Carnahan; 2nd Year, S. A. Rowland; 1st Year, H. Trotter.

The first function of the year was a dinner which was held at the Walker House on October 1th. This served as a reception for the freshmen. A record number of ninety-eight members was present.

The speakers of the evening were Messrs. Dignam, Johnson, Breithaupt and Campbell, all of the Fourth Year. Their subjects were: "Acetic Acid From Acetylene," "Paper Manufacture," "Tanning of Sole Leather," and "Efficiency Engineering," respectively. They were extremely interesting and instructive and proved the value of having members themselves provide the entertainment. Mr. Crawford, also a member of the Fourth Year, furnished some very good music in the form of three piano solos.

The Chemical Club dance was held at the Metropolitan Assembly Rooms on November 3rd. This was also well attended and was generally considered to be a success.

A smoker was held at Hart House on November 23rd. The speakers on this occasion were Mr. J. W. Scott, Chief Chemist

INDUSTRIAL

CHEMICAL CLUB

EXECUTIVE

Standing—

V. B. Lillie
(Curator)
H. Trotter
(1st Year Rep.)
H. M. Dignam
(4th Year Rep.)
E. H. Carnahan
(3rd Year Rep.)
S. A. Rowland
(2nd Year Rep.)

Sitting—

H. N. Baker
(Sec.-Treas.)
Dr. M. C. Boswell
(Hon. Vice-Pres.)
A. E. H. Fair
(President)
Prof. J. W. Bain
(Hon. Pres.)
L. M. Price
(Vice-Pres.)

at T. Eaton's, and Mr. H. F. Robertson of the Third Year. Mr. Scott delivered a very interesting address on "Chemistry in the Control of Industry." Mr. Robertson's talk on "Zinc Refining" was also very instructive.

One of the most successful meetings of the club was held in Hart House on December 7th, when Mr. C. J. Brockbank of Buffalo delivered a paper on "Abrasives, Their Manufacture and Use." His paper was also accompanied by a number of lantern slides. We were very fortunate in having Mr. Brockbank in that his paper proved to be one of the best ever delivered before the Club.

At the next Smoker the Club was favored with an address by Prof. Fay of the Department of Economics. A most interesting address was expected, and the Club members were by no means disappointed. The subject of the address was "Economic Conditions in Europe." At the same meeting Mr. H. A. Fair, '21, delivered an interesting paper on dyes.

The last dinner of the year was held at the Walker House. Again the record for attendance was broken. There were one hundred and fourteen members present. Mr. J. A. DeCew was the guest of the evening. He gave some very valuable advice to the members regarding the problems to be met with after graduation. This was followed by talks from Prof. Bain, Prof. Ardagh, and Dr. Boswell. These were all very interesting, especially that by Dr. Boswell, who treated the subject of research from a different point of view from that of Mr. DeCew. A feature of the evening was the presentation to the upstairs Chemicals, '22, with a cup for their success in the Inter-Chemical Hockey. After a vote of thanks to the executive, the meeting was adjourned by Mr. L. M. Price, the president for the coming year.

During the year a course of lectures on first aid in the Chemical Laboratory was delivered to the Club by Dr. R. B. Stewart. These will undoubtedly prove beneficial to the members who were able to be present. An employment bureau was also conducted this year, but its success was somewhat hampered by the present business depression.

The financial condition of the Club is good. Although the Constitution of the Engineering Society provides for financial aid for the affiliated clubs, it has been unnecessary this year for the Chemical Club to ask for such assistance.

In conclusion, I might say that the year was a most successful one for the Club. The members are to be congratulated on their spirit of co-operation. This, together with the unlimited assistance given by the staff, helped greatly in making the year so successful. Therefore I feel confident that, pursuing policies similar to those of the present, and with the support of all the members, that the future of the Club is assured.

A. E. HAROLD FAIR, Chairman.

CIVIL CLUB

EXECUTIVE

Top Row—

K. W. Irwin
(Vice-Pres.)
M. D. Stewart
(4th Year Rep.)
D. Wyatt
(1st Year Rep.)
F. B. Boswell
(Secy.Treas.)

Bottom Row—

W. W. Abernethy
(Varsity Rep.)
A. R. Chadwick
(2nd Year Rep.)
Prof. C. R. Young
(Hon. Pres.)
G. A. McClintock
(President)
A. A. Rose
(3rd Year Rep.)

## THE CIVIL CLUB.

THE year is about finished and now for the reckoning. During the past year it has been our purpose to have only speakers whose subjects would be of interest to the club as a whole. In this connection we were able to secure Mr. Hogarth, Chief Engineer of the Ontario Department of Highways, for the first. His lecture on "Highways," which appears elsewhere in this volume, was appreciated by an audience of about 100. In our second lecture the elements were against us, for we were forced to hold it at night and as there was a heavy storm on at the time, lighting and power were both off, with the combined result that there were scarcely more than thirty present. The subject, "Reinforced Concrete as Applied to Engineering and Architectural Problems," which was treated by Mr. Engholm in a different light from the usual, was worth more than the effort of attending. What was lacking in numbers was made up in the interest shown. On March 15th we had our final address by Mr. Fowler, Chief Engineer of the Detroit-Windsor Bridge. His subject was the evolution and architecture of bridges and showed the connecting link between the rock bridge of nature, the fallen tree across the stream, and the modern bridge. This was a banner meeting and as there were over two hundred present, it shows that this included many outsiders.

As regards the social side, we had two Smokers. The first one was free and about 90 were present. At this the Old Gull Lakers played the New Gull Lakers at indoor baseball, but as the Old Boys had not been down in Florida training, they were a little off color, and were badly beaten. The sequel to the ball game was a progressive card game where the members at each table decided what should be played. The meeting was addressed by our Hon. President, Prof. Young, whom we wish to thank for the assistance he has given us at all times. After substantial refreshments and the singing of songs, the party broke up. A bunch of first year Miners, each one in the Romanelli class, vied with one another to produce the best music conducive to good card playing. A second Smoker was given in the second term. It was not so elaborate in detail as the first, nor was there as large an attendance. It hardly need be added that the first one was free, whereas the second one cost twenty-five cents per man, the balance being covered by Club funds.

I wish to express my highest appreciation of the members of the executive, who have given valuable time and energy to make the Civil Club a going concern. I am afraid that members are apt to forget that it is the individual that makes up the Club, and in order that it may appear worth while to a speaker, who has gone to no small amount of trouble and inconvenience in prepar-

MINING AND METALLURGICAL CLUB EXECUTIVE

Top Row—

J. C. Adamson
(2nd Year Rep.)
H. G. G. Whitton
(1st Year Rep.)

Bottom Row—

F. J. Lyle
(Entertainments)
W. S. Maguire
(Sec'y-Treas.)
J. Dryborough
(President)
A. H. Stratford
(Vice-President)

ing his address, there should be a good turn-out at all meetings. So now I would suggest that you should all turn out and give your executive the help that they deserve.

In conclusion, I pass on the sceptre and mantle to Mr. McLelland (the Duke), and ask you to give him all the support you can. As for ourselves, we will just say that if we have not done as well as was expected, we have done our best, while on the other hand, if we have done well, it is no more than we should have done. So, Au Revoir.

G. A. McCLINTOCK, Chairman.

## THE MINING AND METALLURGICAL CLUB.

THE Mining and Metallurgical Club has, this year, had the unique experience of functioning during practically the full twelve months. This was owing to the fact that under the auspices of the Club was run the Varsity section of the Student Camp at the Hollinger Mine, which was a signal success. Over sixty School men, from almost all departments, took advantage of the scheme and thoroughly enjoyed their summer under canvas, returning in the Fall with a larger "stake" than the rather scanty employment opportunities available in the Spring gave reason to hope for; with some new experience and with a fund of memories of joys and sorrows, of Hollinger pie, Sunday evening songs and stories, gathering scrap iron, and May snowstorms. There were contingents from Queen's and McGill, and the Student Camp helped to foster and strengthen that friendship between Universities, which only comes of personal contact and undestanding between their members. The Hollinger management took considerable interest in the camp, and talks were given by Mr. A. F. Brigham, General Manager, on "Metal Mining Methods," and by Mr. J. D. McRae on "Hollinger Cost Keeping." In his speech, Mr. Brigham complimented the students on their work and on the manner in which the camp was conducted. A debt of gratitude is owing the Hollinger officials for their kindness and broad-minded attitude in presenting such an opportunity to the undergraduates, and it is hoped that, once begun, the Student Camp will be a feature at the Hollinger in all the summers to come.

Three meetings were held during the Fall Term. The first took the form of a Smoker at Hart House, and was most successful in its object of bringing together the members of the different years. An entertaining programme was rounded off with a short, interesting account of his trip to the Fort Norman oil field by Mr. H. A. Oaks, of the Fourth Year.

The second was taken up with an exhibition of moving pictures on "Rock Drilling," obtained from the United States Bureau of Mines through the good offices of the Sullivan Machinery Co. Then in December, Mr. G. C. Mackenzie, Secretary of the Canadian Institute of Mining and Metallurgy, addressed the Club. He spoke optimistically of the future of the industry in Canada and advised the Seniors, for lack of better employment, to try prospecting for a while.

Following the holidays, at another Smoker in Hart House, Mr. J. P. MacGregor, of the legal firm of MacGregor and MacGregor, spoke on "Company Law," which proved most interesting and called forth much discussion. A point for the consideration of future executives might, with advantage, be mentioned here; that it is not well to procure speakers on technical subjects only, but to have business men, lawyers and others, also address the Club, bringing the layman's point of view and ideas.

A new departure for the Club was a skating party, followed by a short dance. This was a distinct success, largely due to the efforts of Messrs. Heisey, Dumbrille and Brown, who were in charge of the affair.

At the last meeting, a film on "Silver Mining" was shown, followed by a brief instructive lecture on "Heat Treatment of Brass," by Mr. O. W. Ellis of the Department of Metallurgy, and illustrated by lantern slides.

Thanks are due to the speakers who addressed the Club and to members of the Faculty who assisted in procuring these speakers and gave helpful criticism and advice. The executive consisted of A. H. Stratford, Vice Chairman; W. S. Maguire, Sec.-Treas.; J. C. Adamson, Second Year Rep.; H. G. G. Whitton, First Year Rep., and F. J. Lyle. Entertainment, and the success of the year's activities is largely due to their co-operation and labor. Mr. W. S. Maguire is the newly elected Chairman and the affairs of the Mining and Metallurgical Club can rest in no abler hands. May all success attend his efforts in the coming year.

JOHN DRYBROUGH, Chairman.

# SPASMS

THE second annual Spasm was held in Massey Hall on the evening of December 1st, 1921. A splendid array of talent and a well filled house went to make this event a huge success and Spasms is assured of a prominent part in the future "School" programme.

The executive committee, in charge of Mr. C. T. Carson, deserve a great deal of praise for the time and work they put in and for the results obtained. Under the practised eye of Mr. Digby Wyatt, '25, stage manager, rapid and smooth staging and shifts were effected without awkward delays, a feature usually noticeable by its absence in amateur productions. A word of appreciation is also due Mr. R. M. Laurie, '24, and Mr. Geo. F. Bryant, '22, for their efficient handling of the innumerable details of the business management and advertising. To the casual observer these details are usually entirely overlooked, but they are, nevertheless, of primary importance to every production.

Limited space will only permit a few honorable mentions of which there should be many. The cup was won by the Class of 1923, Civils and Miners, for their production of "Surveying." This skit was all "local color" and very well done. Several freshmen sustained strained necks in trying to get a second look at the lady. No one happened to be watching any of the staff.

An exceptionally good tumbling act was provided by the School gymnasts. These men looked like professionals and the applause which they received was a good measure of their success. The "heavy" drama was provided by the fourth year Chemicals, and the "heavy" music by McNamara's Band. The Band presented an array of gold braid and multi-colored costumes and played several difficult numbers—these numbers were difficult in that the audience experienced difficulty in recognizing them. The best thing about the Band was the fact that it was disorganized immediately after the performance.

Many good musical numbers were presented, especially by the quartette. These four gentlemen received the same hearty applause as they did last year and delighted the audience with their excellent programme. The School Glee Club presented a rather original number, "The Toronto Dislocation C.," with considerable "local color," which was very favorably commented on by the audience. The setting displayed an originality of choice which perhaps gave this number its greatest charm, apart from the rendering of the songs. What more romantic setting could be conceived than, say, the corner of College and Teraulay, at the witching hour of midnight, on a wet night in late November? The night gang of "dislocators" have just knocked off for supper, and while gathered round the cheery brazier, beguile the weary

SPASMS

COMMITTEE

Back Row—

G. F. Bryant (Publicity)
C. B. McQueen (3rd Year)
D. Wyatt (1st Year and Stage Mgr.)
R. R. Parker (4th Year)
A. M. Johnston (Master Electric'n)

Front Row—

R. M. Laurie (Business Manager)
C. T. Carson (Director and Chairman)
Craig Hamilton (Mus. Director)

moments with songs. A belated wanderer from a "wet" party zigzags upon the scene, and with a stray "cop," decides to throw in his lot with the gang. There were also some good single acts, prominent among them being a dance by a beautiful lady in a fiery costume. The music was provided by Toike-Oikestra, an "All-School" organization, who received the fruits of their labor, not in the form of cabbage and bricks, but in applause and appreciation.

The second Spasm, as well as the first, went to prove that the School of Science provides an education which is not too technical and that the energies of the engineer are not misspent when directed along lines other than engineering.

The committee wish to acknowledge the kindness of the Players' Club in loaning the electrical equipment, and they are also indebted to Mr. A. M. Johnston, master electrician of the Players' Club, for his efficient handling of the lights.

# ARCHITECTURE

THE Architectural Club of the Faculty of Applied Science, although the smallest club in the Faculty, has always been a very active organization, and this year of 1921-22 has been no exception to the rule. Owing to the large number of activities and the amount of work entailed in the curriculum, it was decided at the beginning of the term to limit the meetings of the Club to one a month, when some well known architects would be asked to deliver addresses. Under the guidance of the following executive, a very successful year has been passed: Hon. President, Prof. Adrian Berrington; Chairman, J. B. Helme, '22; Vice-Chairman, M. A. Norcross, '22; Treasurer, J. G. Magee, '23; Secretary, P. A. Deacon, '24; Councillors: F. B. Brown, '23; E. Coleman, '24; W. H. Steele, '25.

THE

ARCHITECTURAL

CLUB

EXECUTIVE

Standing—

J. G. Magee (Treas.)
W. H. Steele (1st Year Rep.)
E. M. Coleman (2nd Year Rep.)
F. B. Brown (3nd Year Rep.)

Sitting—

J. B. Helme (Chairman)
Prof. Adrian Berrington (Honorary Chairman)
M. A. Norcross (Vice-Chairman)
Abesent—
P. A. Deacon (Secy.)

It might be said that owing to the greatly increased activity of the University Sketch Club, to which practically the entire department belong, opportunity has been given the students to hear prominent artists speak and demonstrate, which otherwise would have been taken up by the Architectural Club and included in its work.

The opening meeting was held the latter part of October in Hart House and took the form of a luncheon, at which the Club got away to an excellent start. We were favored with the presence of Dean Mitchell and Prof. C. H. C. Wright, besides three members of the O.A.A., Mr. Hynes, Pres. O.A.A., Mr. West and Mr. Wolsey, Secretary O.A.A. Several graduates of the department also were present and, along with the undergarduates, helped to give the necessary impetus to the first meeting.

Mr. Hynes, who has been very much interested in securing adequate protection for the architectural profession, and who has been an ardent backer of the Architects Bill, under discussion in the Ontario Legislature, gave the Club an illuminating address upon this important subject, covering in the course of his speech, the history of the Bill from its first beginnings. Mr. Hynes particularly stressed the point that it was not the duty of the practising architects to educate the younger "rising generation," but this was up to the community as a whole, or the Government, who were the ones who would profit by such education. He stated the architects would do all they could to help, but they must not be relied upon totally.

Mr. Hynes notified the Club that the O.A.A. had decided to give a scholarship of $100.00 to the student taking the highest average in Second Year, and that in the future medals would be presented to any outstanding undergraduates who attained special mention in their work. After a short talk around and discussion upon several questions brought out in the course of the speech, the meeting was adjourned.

The second meeting of the Club was held in Chemistry and Mining Building, when Mr. H. S. Brightley, service engineer of the Indiana Limestone Quarrymen's Association, gave an address on Indiana Limestone, illustrated by moving pictures. This meeting was opened to the Architectural Draughtsmen's Association of the city, and also the Stone Cutters' Association, and was exceptionally well attended. Mr. Brightley explained and illustrated the various stages of the game, from the quarrying to the placing in position of the finished product in buildings.

Owing to the stress of work in the department, no meetings were held in the second term until March, when Mr. John M. Lyle, architect, gave the Club an excellent address on Modern American Architecture, a summary of which is printed in this number of the "Transactions." Mr. Lyle has upon previous occasions honored the Club with lectures which have always

S.P.S.

DEBATING CLUB

EXECUTIVE

Top Row (L. to R.)—

W. A. Becker
(2nd Year Rep.)
S. M. Jones
(1st Year Rep.)
J. A. Paget
(3rd Year Rep.)
W. A. Osbourne
(Sec'y-Treas.)

Bottom Row—

Prof. C. R. Young
(Hon. President)
D. W. Rosebrugh
(President)
G. F. Bryant
(4th Year Rep.)

proven a source of inspiration to the members, and it goes without saying that a "capacity house" was on hand to hear him discuss this very interesting subject.

The senior members of the Club have been fortunate also in having Mr. H. H. Madill take them on several tours of inspection, amongst these being visits to the Gurney Heating Plant in West Toronto and the Macgregor-MacIntyre Steel Company's plant. It is expected that the Annual Undergraduates' Exhibition of Architectural Work will take place shortly in the Sketch Room, Hart House. Last Spring this exhibition was a great success and was well attended by people outside of the University, as well as the undergraduates.

M. A. NORCROSS, Vice-Chairman.

## THE DEBATING CLUB.

A DECIDED forward step was made during the year by the institution of a short course of lectures and criticisms on public speaking by Professor Greaves of Victoria. It was felt that it was time that those members of School who were really interested in public speaking should receive some expert criticism of the faults in their manner, style and delivery, and Professor Greaves filled this want. The course was not long enough to correct many faults but it gave to each man a clear idea of what his mistakes were and of how to proceed to correct them.

As Socrates said, "There are three stages of knowledge, first, one is ignorant and knows it not; secondly, one is ignorant but realizes his ignorance, and lastly, one is learned." If the members of the Debating Club cannot claim to have reached the third stage of knowledge they have nevertheless passed the first!

Last Fall, School were unfortunate enough to be defeated in one of the I.C.D.U. debates by Dents, which eliminated us from the Inter College Debates, but our men made a most excellent showing and need no alibis.

This session the First Year were again the victors in the race for the Segsworth Shield for Inter Year Debating. The Third Year were the runners up.

In a meeting held in February, the Engineering Society Cup for the best speaker in School was awarded to "Tim" Weldon of '22. In criticizing the speeches in this contest, Professor Greaves remarked that their quality was a decided improvement upon that exhibited the previous year. If this is true, which we hope it is, the course in public speaking certainly produced some tangible results.

It is too soon yet to make a definite announcement, but there are good reasons for believing that Public Speaking will be upon

S.P.S. - Y.M.C.A.

EXECUTIVE

Top Row—

C. McKeown (Bible Study)
A. W. MacQueen (Social Service and Boys' Work)
A. M. Reid (International Relations)
F. Spence (New Student Service)

Bottom Row—

L. C. Jackson (Sec'y-Treas.)
T. S. Glover (President)
Prof. R. W. Angus (Hon. President)
J. H. McIntosh (Vice-President)
D. Burns (Publicity)

the curriculum for some of the classes next year. If this is put into effect, the importance of the Debating Club, as being the "lab" where theory is put into practice, will undoubtedly be increased.

Congratulations are in order to Mr. A. V. Price of '23 upon his election to the Chairmanship of the Debating Club for next year. Mr. Price has shown a consistent interest in the Club from its inception in 1919. He brings to it a fresh enthusiasm and energy that one who has been too intimately concerned in its councils might not have, and I am sure that under his guidance next session, the Club will have a prosperous year.

D. W. ROSEBRUGH, Chairman.

## S.P.S-Y.M.C.A., 1921-22.

UNDER the leadership of the President, Mr. T. S. Glover, the activities of the Y.M.C.A. during the present session have been quite gratifying.

The session opened with the memory of the Elgin House Conference with all its inspirations firmly impressed on the minds of those who were fortunate enough to have attended.

The first important action was to entertain the Freshmen with a social "get-together" evening in Hart House, where the number of their acquaintances increased by bounds.

The Executive met almost weekly and formulated plans and programmes for the year. The Committee on Social Service obtained the time and help of several students to work in the Ward, the University settlement, etc., certain evenings for the uplift of those less privileged and less educated citizens of our city.

The Committee on Study Classes organized several groups of students studying questions of great importance to all. The fact that these groups have increased rather than decreased in attendance during the term indicates the value of these religious discussions to engineers developing a four-fold life.

The past year has been characterized by a realization by the nations of the necessity for international understandings and the need for placing international relationships on better foundations. Dr. John R. Mott, when addressing the University of Toronto in January, stressed the point that such foundations are to be found in Christian principles. That the engineer can play an important part in creating better world conditions will be readily admitted.

A discussion group, under the rather formidable title, "The Committee on International Relationships," with A. M. Reid as Chairman, has been considering the many problems suggested by the above in a series of weekly meetings. Each member has presented a paper on some aspect of the enquiry, and interesting discussions have followed.

FOURTH
YEAR
SCHOOL
EXECUTIVE

Back Row—

L.J. Robinson (Varsity Rep.)
G. A. McClintock (Civil Club)
A. E. H. Fair (Chem. Club)
J. B. Helme (Arch. Club)
J. Dryborough (M. & M. Club)
W. C. C. Duncan (E. & M. Club)

Front Row—

J. G. Spotton (Secy.-Theas.)
S. L. Coulter (President)
J. Roy Cockburn (Hon. Pres.)
B. H. Johnston
H. G. Thompson

Absent—
A. K. Greig (Athletic Rep.)

While tangible results prove such discussions are difficult to define, the clarifying of ideas and the broadening of outlook resulting therefrom must prove of value. Canada has attained to national status largely through her contact with other nations in the war, so the individual rises to new ideas as he realizes the condition of the "under-privileged" in the world and the need for those who enjoy much to contribute to the welfare of the many.

Mention might be made of the Handbooks which were made possible by the Y.M.C.A. during the summer, which though they almost paid for themselves by their advertising, yet entailed a very great amount of labor in their preparation.

During the year the Y.M.C.A. in S.P.S. was the means by which about two hundred and forty dollars was raised for charity amongst our own students. This was divided among the University Settlement, Star Fresh Air Fund and Sick Children's Hospital.

LLOYD C. JACKSON, Sec.-Treas.

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THE graduating class of 2T2, having arrived at the time when it ceases to be an undergraduate body, and its individual members must each follow their own paths in the world, may rest assured that the activities of the past season, in their nature and scope, have been second to none in the history of any class in the past.

The first event of note during the Fall term was the trip to the Chippawa-Queenston power development on October 6th. Through the kindness of the local executive of the E. I. C., who instituted the affair, many of us were able to visit, under ideal conditions, this stupendous creation of Canadian engineers. Although the invitation of the E. I. C. was extended primarily to the senior year, yet there were many of the junior years who availed themselves of this opportunity, and all expressed deep appreciation of the efforts of those who organized the trip.

About this time various members of the class seemed to be developing into book-worms. There was manifested a fondness for the seclusion of the School library, which at any other time might have been looked upon with suspicion or distrust by the normal School man. This activity, coupled with the writing of copious notes, became more pronounced towards the close of the Fall term, and there were many who carried a harassed look about with them. There is reason to believe that a few unfortunates developed writer's cramp during the vacation!

Early in November the year held a smoker in Hart House, and the evening was enlivened by indoor baseball between Electricals, Mechanicals and Chemicals and the Gull Lake team. Armistice night saw the class gathered at the Metropolitan Assembly Rooms on the occasion of an enjoyable year dance.

The advent of the New Year saw many of the cares of the previous term happily relegated to the past, with the prospect of a busy season, both social and academic. An interesting feature during February in the sporting line was the Inter-departmental Hockey, which helped to promote much friendly rivalry between the various groups. A more informal type of rivalry between the Hydraulic and Thermo Electricals was much in evidence in the study room, and was not confined to any specific date, being merely spasmodic, but none the less effective, in enlivening an otherwise monotonous life.

In the various branches of sport 2T2 has not been behind. Beattie Ramsay has made an enduring name in the annals of senior hockey; Schemnitz has taken his place as a boxer for the Faculty; "Spike" Carruthers as captain of the Track Team; Bishop, Smillie and Glover on the Soccer Team, while the Gym. Team has Williamson, S. Williams, and R. E. Parker. "Tim" Weldon was judged to be the best public speaker in School, and he also took an active interest in the Students' E. I. C.

An account of the year's history would not be complete without some mention being made concerning the active interest taken by Prof. Alcutt, our new member of the Staff, recently arrived from England, in entering so whole-heartedly into many of our activities, and who has so generously given his time and hospitality, in order to make our acquaintance.

We were very fortunate in being given the opportunity to listen to a number of eminent engineers on various phases of hydro-electric engineering, a subject which is of particular value to many of us who will be intimately connected with this branch. Our thanks are due to Prof. Angus, whose untiring zeal and interest in our welfare, both now and in the future, made this series of lectures possible.

The crowning event, of course, was the Graduation Dance, held at Jenkins' Art Galleries on February 23. The patronesses who graciously consented to act were Mrs. C. H. Mitchell, Mrs. C. H. C. Wright, Mrs. J. W. Bain, Mrs. C. R. Young, and Mrs. E. A. Alcutt. The consensus of opinion was that a more enjoyable dance had never been held in the history of the class.

The permanent executive was elected with "Spike" Thompson as President, Beattie Ramsay and D. L. Pratt as Vice-Presidents, and "Tim" Weldon as Secretary-Treasurer.

We have come to the threshold, and looking back on our life in the University with mixed feelings of pleasure and regret, set our faces toward the new life which is opening out before us. Amen.

STANLEY L. COULTER, President.

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THE class of 2T3 has almost completed the third stage of its journey through School. Even though our numbers have decreased from 402 to 286, the spirit of co-operation and energy which has been so typical of 2T3 in all its activities has not decreased in the least with numbers, but, on the contrary, has increased, as a survey of the activities of the past year shows. Individually and collectively the past year has been everything that could be desired. The individual activities of the class have not been confined to the class or school, but are widespread throughout the university.

In Varsity athletics the class of 2T3 takes second place to none. Every first team has one or more 2T3 men on it; the only team on which the class is not represented is the Women's Hockey Team, and that isn't their fault. Some of the men on those teams are:

Rugby—Duncan (captain during the past season), Rolph and Carew.
Soccer—M. O. Evans and N. F. Johnston.
Hockey—Evans.
Gym. Team—Wolsey.
Water Polo—Bell, Fitzgerald, Wells, Conklin and Harston.
Swimming—Fitzgerald, Harston and Wells.
Basketball—Duffell.
Track—Bell and Langford.
Rowing—Bell.
Boxing—Goldie.

Thirteen T's have been won in the past three years by members of the class, a record any year can well be proud of. Not only in Intercollegiate athletics are 2T3 men active. Most of the School and Senior School Interfaculty teams have a remarkable number of our class on them. Thirty-six T's are the prize for this.

Not only in athletics has the class been active. This year

MECHANICAL

AND

ELECTRICAL

CLUB

Back Row—

Prof. E. A. Allcutt (Hon. President)
W. R. Carruthers (1st Year)
Prof. H. W. Price (Hon. Pres.)
H. J. Pugsley (2nd Year)

Front Row—

W. L. Yack (4th Year)
W. C. C. Duncan (Chairman)
J. G. Inglis (3rd Year)

one of our classmates, Tony Reid, started a Student Branch of the E.I.C. in the School; since then, McGill and Queen's have had branches started there too. Several papers were read before meetings of the branch by members of the class. Tony deserves great credit for his work in this connection. The class was represented on Hart House committees. Terry Carson was chairman of the Spasms Committee. The best skit, which won the trophy, was put on by members of our class. The University of Toronto Glee Club had its quota. Herb McManus was Business Editor of the Varsity. Many took a great interest in the Toike Oikestra. These are just a few of the individual activities.

The 2T3 Year Dances have always been looked for with eager anticipation. This year was no exception and the affair, which was held at Columbus Hall, lived up to expectations. Four hundred of the members of the class, and their friends, joined together in making the dance the best yet. Everyone enjoyed it to the very last. The Tea Dance must not be forgotten although it has not taken place yet. It promises to be one of the most delightful social functions of the year, although it is the first of its kind that the class have held; but 2T3 are behind it, therefore it needs will be a success.

In closing, I should like to take this opportunity of thanking the executive for their excellent work and the year as a whole for their co-operation and support.. As a result of the recent elections, Bob Morrison is our new President, and we wish him the very best.

JOHN FARLEY, President.

SPS APPLIED 2T4 SCIENCE

LAST September, when the class executive for the current year took over from its capable predecessor, the first thing to do was to examine the membership. The class sustained the inevitable losses due to the "Spring Handicaps" and a few members dropped out for other reasons. But, regrettable as these losses were, they were undoubtedly compensated for by a score or so who were promoted from 2T3, and by eight students from other colleges.

The evident "greenness" of the freshmen could not long be ignored. So, early in the term, their many admirers in the second year gave them a reception in the Old Gym., the warmth of which was surpassed only by the variety of methods employed. This contact with real School men was of great benefit to the new arrivals and the latter were loud in their expressions of appreciation, many commenting favorably on the impartiality of the

TOIKE - OIKESTRA

Top Row (L. to R.)

W. S. Yates
P. C. Davidson
G. H. Voaden
H. F. Robertson
D. D. Flett
W. G. W. McKenna
C. L. Spence

Bottom Row—

K. G. B. Ketchum
P. S. Edwards
A. Kingsmill
C. T. Carson
K. Griffin
S. R. Muirhead
S. R. Lavender

Absent—

C. Hamilton
(Conductor)
J. E. Buchan
(Pianist)
G. S. Moybury
T. M. West

treatment they received. The whole ceremony was ably organized and conducted under the leadership of Tom Kingston.

Having seen something of the Frosh, the next step was to see something of each other. With this end in view, a smoker and a class dance were held in November. The smoker took place in Hart House, and was one of those parties at which everybody sings whether he can or not, and everybody enjoys himself whether he wants to or not. This enthusiastic gathering of the clans was engineered by a committee headed by "Roger" Crossgrove. The arrangements for the dance were "convened" by "Chuck" Sharpe, and he and his assistants, ably supported by a large number of classmates, showed their guests that 2T4 *can* stage a dance.

Before the first term ended, the worthy freshmen insisted on returning the sophs' hospitality at a smoker down town. They "did us proud" at the Prince George, and the united efforts of the two years produced stresses in the rafters of that hostelry that will not be equalled for many years to come.

The class dance in November was a rare treat no doubt, but even that would not satisfy some "shakers of a wicked leg." So the class returned in force to Columbus Hall one Saturday afternoon in February, and had such a good time that a regular epidemic of tea-dances may be expected from 2T4 next year.

In addition to Interfaculty and Intercollegiate sports, in which the year is as well represented as any, two Interdepartmental schedules were played within the year. Mechanicals won the Water Polo championship of 2T4 and Electricals the Hockey. Handsome trophies had been provided, but after they were used on election night they could not be located. However, the members of the winning teams are being presented with pennants by which to remember their victory.

In a Faculty like Applied Science, there is some danger of groups becoming isolated from the rest of the year. It should be the task of every class executive to overcome this danger as far as possible. Considerable success has attended the efforts of the two year committees 2T4 has had so far. May the other two be even more successful. With Bill Reid as President next year, nothing should be impossible.

Mention should be made in closing of the latest arrival in the class, Ralph Lockwood Robinson, born a few weeks ago, who received a christening mug from his 195 godfathers in 2T4.

J. M. DYMOND, President.

EVERY year a collection of young men gather in the first year draughting room to "swap" acquaintances. Many have friends among the crowd; many, probably the majority, are total strangers. An observer might hear such queries as "Where are you from" "Do you know ——?" and the like, and he would probably conclude that some means of forming new acquaintances should be instigated.

This happy thought was borne forcibly to the minds of several seniors and juniors, with the result that the new aspirant "Ngynrs" were provided with an unfailing means of identification.

A tie is a more or less conspicuous portion of a young man's apparel, varying directly in conspicuousness as the hue. As Mr. Webster no doubt remarks, the word "green" is applied to a novice, an apprentice, or one seeking the first stage of mental enlightenment. Why should not some insignia of that color adorn a seeker of knowledge to identify him from other ordinary mortals?

For a month we suffered publicity and then the sophomores treated the assembled year to a whacking good time, also relieving us of our now severely stretched neckwear.

We had now blossomed forth as Student Engineers and were henceforth "School men." Was not the final reward worth the indignities suffered by our respective persons? It was!

Our year was now under way. After untiring work on the part of the elected executive, our late tormentors received good in return for evil, and were entertained royally at the Prince George by the Freshmen. That night was fittingly described in the "Varsity," and everyone had a thoroughly good time.

Many of our men were members of the School Rugby teams and here they acquitted themselves admirably. In the Debating Club our members were successful in annexing the Segsworth Shield, thus proving themselves capable of taking their place amongst the best. Early in the following Spring the year held its class dance at U.T.S. The event was greatly enjoyed and fully repaid the executive for their time and trouble.

The year is broadening out in experience and before the close of the 1922 term will be united into a smooth, easily working organization. The class contains some very young members in comparison with other years, but they are fully imbued with "School spirit" and will, I am sure, live up to the high traditions set by School men in the past.

HAROLD L. NORMAN, President.

# THE GULL LAKE SURVEY CAMP.*

By J. W. Melson, Lecturer in Surveying.

"PADDLES up, Spike," came a voice from the stern of the Peterboro canoe as she came around the bend at the head of a swift bit of river, "these balsams look to me like the makings of a pretty good bed."

Measurement of stream flow with current meter.

"Righto, your honour. I'm agreeable. By this time to-morrow we ought to make Varsity Bay if this map and my judgment are at all reliable."

Conversation similar to the above is to be heard on about the nineteenth or twenty-ninth of August along the canoe route from Bobcaygeon to Haliburton at a point about one day's paddle from the Gull Lake Surveying Camp.

In this camp our students in Civil and Mining Engineering get their Third Year field work in Surveying for six weeks and a month respectively. The Haliburton division of the Grand Trunk Railway from Lindsay north is the recognized route into this country but the old canoe route is still the choice of some students who prefer that means of travel and also wish to have their canoes by them during the stay in camp.

Students in Civil Engineering are requested to report at Gelert on the Railway on August 20, whence to travel by stage eight miles to Minden on the Gull River and then, in a scow towed by a steamboat, five miles down the river and around the shore of Gull Lake to the University Camp. Students in Mining Engineering are expected to do likewise on September first; all to remain in camp till the Fall term opens in Toronto.

As recently as 1919 all the Surveying Field Work was done —i.e., what could be done was attempted—in the University Grounds at Toronto, but as this had always seemed but a weak imitation of what practical Surveying should be, it was resolved by the staff in Surveying that a camp should be located somewhere in the country far from the inconveniences of the crowded city where the man behind the telescope could be given a chance to open out and use the instrument as it was intended it should be used and not tie it down to toy railway lines and imaginary power sites. But the trouble was not all with the riverless bridge-building, the quantity of the work was affected as much as the quality. Could a student be expected to produce results with eighty per cent. of his time-table taken up with other studies and his chances for slipping down town of an afternoon so easy? And, moreover, with co-education in full swing, why is a telescope anyway, and is it reasonable that a steel tape should always lie flat on the side-walk?

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*Reprinted by kind permission from the University Monthly.

The outcome of all this was a scouring of the north country by Professor L. B. Stewart and Mr. Banting in search of a territory where many varieties of survey work could best be conducted. An eighty-acre lot was purchased on the north shore of Gull Lake in Haliburton between the points where the Gull River glides in and where Rackety Creek lowers its foaming waters, a hundred feet in 400 yards, from the Bob Lakes.

As well as the actual University property, students have the run of the roads and lake shores in the neighbourhood. This expanded area gives opportunities for long-distance work. such as Secondary Triangulation, Camera Survey, Differential Levelling, Stadia Traverses, Shore Line Surveys and Highway Improvement Surveys.

There is one stretch of beach quite close to the University which is admirably suited to Base Line Measurement. Hairs are split about as fine on this linear measurement as they are on the angular measurement of the triangles.

Hydrographic work is done in the University Bay, such as water lot surveys and spot soundings, and up Gull River, where

Main Building and Staff Offices.

the amount of flow is measured. The illustration shows a party in the act. Hanging from a cable they have sounded the river from bank to bank and are now going over the course again with the current meter measuring the speed of the stream as it varies from one side to the other. It is proposed to use the basin of Rackety Creek as the site of a hydro-electric power development scheme next year, its condition being ideal for such work.

Within the area of the University Lot, such standard surveys as, Stadia Topographical, Micrometer, Boundary Line Traverse, Mine Surveys, Railway Cross Sections, and Spiral Curves, etc., are run. The Railways are now full sized and the vertical lines in the Mine Survey run down the cliffs at the foot of Varsity hill which rises 150 feet above the Lake instead of down between the steps in the Old Red School. These cliffs hang over about seven feet. Toward the end of the season the astronomic work is done. "Altair" and "Alpha Lyrae" make ideal time stars and of course Polaris is unfailing for Azimuth work.

To encourage the beginners in Astronomical work a "Latitude with Sextant" observation is taken from the sand close to the Lake, using the real horizon of the Lake as a reference line and sighting the sun. This is the time-honoured nautical observation and serves to show students that Astronomy may not be so difficult after all.

Serious work is done at Gull Lake from nine to five, including drafting of work that is done simultaneously in the field. Of the four University buildings, the main building is the one shown in the illustration which contains one large and four small rooms, used for lecturing and drafting principally, but also used as studies in the evenings and as storage for the instrumental equipment.

But all is not taken seriously at camp, and the student is not overburdened with toil. After 5 o'clock he indulges himself in all the varieties of amusement that offer. Generally it is a swim and dive first. At the diving ladder on the point, all heights from two feet to eighteen can be taken into fifteen feet of water and within a few feet of the shore at that. Eating is not one of the least interesting pastimes to which the boys are given. The one and only call is invariably followed by a stampede. After supper the evening may be spent at baseball on the clearing in the middle of the lot, for this place is an abandoned farm, or in punt-racing, providing the season is early and the days long. Should the evenings be dark, then roll a few logs together and tune the cigar-box banjo. This said banjo is not such a musical horror as might be supposed, especially when the full chorus tries to drown it out. In fact, on a still evening the effect of the bon-fire and the chorus is very pleasing.

When the above pleasures fail to draw the man, then he may be certain to find just the proper weight of fiction or animal story in the Gull Lake Branch of the University Library consisting of some hundred books. What a homelike place is that bunk-house with its eighty beds! Here are boys playing cards, there is a group known as the "Calculi" grinding for a supplemental, and everywhere else are the individuals each in his own setting of undress comfort.

The drinking water is taken from a spring on the grounds. A pumping station supplies the buildings with water.

Besides the main building, bunk house, and dining-room-kitchen, there is the staff cottage, containing offices for the faculty which consists of Professors Treadgold and Crerar, and Messrs. Banting and Melson. Underneath the staff building is the photographic dark room where the Camera Survey pictures are finished and where students are given every encouragement in amateur work, being supplied with the necessary equipment and having at their disposal a film-tank developer.

"Well, Spike, Old Horse, we did that lake in about half the time it took us coming up."

"Quite right, Mel. I'm a new woman since I came to this place."

"How do you account for it?"

"I'll say it's partly the piny breezes, partly the thousand feet up, and partly the grub. But oh, that steady outdoor exercise, and that good fellowship around the camp fire!"

So ends the Gull Lake season and at the same time so begins the life-long season of friendship.

The First and Second Year's field work in Queen's Park serves effectively to prepare a student for genuine surveying in the Third Year, and this Third Year work gives him confidence to undertake a profession that requires a sound knowledge of Surveying. Those with special skill and tastes may perhaps devote their time to the subject, and take the Astronomy and Geodesy option in the Fourth Year.

# THE ENGINEERING INSTITUTE OF CANADA.

## Student Activities.

By A. W. McQueen.

IN last year's issue of "Transactions," no mention was made of the activities of the student members of the E. I. C. at School. This year it was felt that no book, which included in its subject matter brief accounts of what has taken place among the students at School, would be complete without some reference to the activities of the E. I. C. members.

Early in the session of 1920-21 an enthusiastic committee of students was formed under the chairmanship of A. M. Reid, to boost the E. I. C. at School. Naturally the first task of the committee was to get members. There was already a small nucleus of members at School and before the end of the term this nucleus had increased by over one hundred new members.

The officers of the Toronto Branch were very keen to help and, acting on suggestion from the School committee, obtained permission for parties of students to visit ten of the more interesting plants and engineering enterprises in the city. Several hundred of the students took advantage of this arrangement during the year.

In February the Annual Professional Meeting of the Institute was held in Toronto and a Service Committee of students from School did very fine work by helping with the details of the convention.

During the present session of 1921-22 the members of the Student Committee, E. I. C., found themselves very busy with many things and thought that their best policy would be to consolidate the ground they had won. To this end a Students' Night was organized and held in Hart House, late in November. The speakers were students who gave short talks on engineering subjects in a way which reflected great credit not only on themselves, but also on the Faculty to which they belong. So successful was the meeting that another and similar one was held early in February. It is believed that these meetings are unique in character so far as Canada is concerned.

To those who are not familiar with the E. I. C., it may be said that the Institute is the professional society in this country and embraces in its membership all classes of engineers. Practically all the prominent engineers in Canada are members and its membership has increased nearly sixty per cent. in the last five years. The Institute aims, among other things, to help its members in every possible way, and to enhance the usefulness of the profession to the public.

**SCHOOL**

**DINNER**

**COMMITTEE**

Top Row (L. to R.)—

W. D. Jewett
W. R. Richardson
C. H. Van Horne
S. M. Jones
J. M. Drymond
F. B. Coles

Bottom Row—

E. W. Cockerline
J. A. Langford
S. L. Coulter
C. A. Norris
W. E. Carswell

# THE SCHOOL DINNER.

THAT ancient and honorable institution which is the safety valve for excess School spirit, was held on Tuesday, December 6th, 1921, at Bingham's Down Town. This Thirty-Second Annual Banquet had a unique feature in that it was held on the night of the Dominion General Elections, and announcements of election results from time to time during the evening added "pep" to a very entertaining program of toasts and music.

Over three hundred sat down to a "capacity" meal during which the "Toike Oikestra" co-operated with the chef in a combined assault on ear and palate, producing that happy state of mind which is the secret of the Dinner's popularity.

The usual toasts were given, the speakers being introduced by Jack Langford and received with wild enthusiasm. Beattie Ramsay, in his own words, "faced off the puck" in splendid style by proposing "The University." Principal Maurice Hutton responded as only Principal Hutton could. Being a Classics scholar, he naturally delved far into the misty past and, having related Socrates' experiences with engineers, he passed into the realm of mythology by referring to the time when "The Varsity" was read for its literature. Dean Mitchell and Prof. C. H. C. Wright, in order, no doubt, to persuade themselves that they were not as young as they felt, both recalled their freshman days. The Dean was present in his freshman year at the first School Dinner and in Prof. Wright's freshman year an event of scarcely less importance occurred in that Eastern and Western Canada were linked by rail.

Other speakers were E. L. Cousins, '06, of the Harbor Commission, W. A. Osbourne, '24, "Spike" Thompson, '22, W. E. Bennett, '23, and representatives of McGill, Queen's and R. M. C. Entertainment was provided by the Science Quartette, "Long Willie's Jazz Hounds," and Prof. E. A. Allcut. The latter was tried on the charge of being three weeks late at the beginning of the term, and sentenced to sing for it. The sentence was carried out on the spot, much to the satisfaction and delight of those present.

Stan. Coulter and his committee are to be congratulated on a Banquet at which that intangible but essential spirit of good fellowship was in evident abundance.

**SCHOOL**

**DANCE**

**COMMITTEE**

**Top Row (L. to R.)—**

**G. Lindsay**
**W. A. Osbourne**
**C. B. MacQueen**

**Bottom Row—**

**J. A. Langford**
**J. Dryborough**
**(Chairman)**
**K. L. Carruthers**

**Absent—**

**H. H. Lawson**
**D. A. S. Lee**

## THE ENGINEERING SOCIETY ANNUAL AT HOME.

THE Annual Science "At-Home," School's biggest social event of the Spring Term, was held at Hart House on Feb. 3rd, 1922. This event, always successful, was even more so on this occasion, and deservedly so, after the efforts which had been put forth on its behalf by the committee in charge, aided by a number of willing helpers. The following ladies kindly consented to act as patronesses: Mrs. C. H. Mitchell, Mrs. C. H. C. Wright, Mrs. H. E. T. Haultain, Mrs. P. Gillespie, Mrs. J. W. Bain, Mrs. C. R. Young, Mrs. T. R. Loudon.

One of the most commendable features of the dance was the decorations, and those who are acquainted with Hart House Gymnasium will concede that this feature requires much consideration. The "false ceiling" effect, obtained by the use of paper streamers and the abundant and tasteful display of flags, told of infinite painstaking on the part of those responsible. To this was added a lighting effect which also bespoke of School brains, and which gave to the scene a glow of happiness which contributed much to the success of the evening.

The favorite sitting-out rendezvous was the gallery of the beautiful Hart House pool. A novel feature was here introduced by providing amusement in the form of an exhibition of high and fancy diving.

Supper was all that could be desired and the arrangement of the dance programme so as to allow three dances between supper sittings, proved to be a great factor in avoiding delay.

As regards the programme, nothing more need be said than that novelty dances, including "Snowball" and "Balloon" dances were in evidence and "wandering moonlight beams" supplied with wonderful effect by the aid of a spherical mirror, which excited much comment. J. Wilson Jardine supplied the music and co-operated with the committee in running the dances on schedule time.

The Dance Committee and those who helped them are to be congratulated on having added another to the long list of School functions, and one which was of outstanding merit and worthy of the best traditions of School.

S.P.S. ATHLETIC ASSOCIATION

R. C. Relyea (Sec'y-Treas), F. S. Seabourne (3rd Year Rep.), W. B. Ramsay (President), D. L. Polack (1st Year Rep.), K. V. Heyland (2nd Year Rep.), G. W. Smart (Vice-Pres.)

## SCHOOL ATHLETICS, 1921-22.

### Executive for 1921-22.

| | |
|---|---|
| President | W. B. Ramsay |
| Vice-President | M. P. MacLeod |
| Secretary-Treasurer | R. Relyea |
| 4th Year Rep. | K. Greig |
| 3rd Year Rep. | F. S. Seaborne |
| 2nd Year Rep. | K. V. Heyland |
| 1st Year Rep. | D. L. Polack |

SCHOOL has completed another one of its successful years in the sporting activities of the University. Every Varsity team has had a large percentage of School men on it. This is the spirit that School has always stood for and is one that should ever be foremost in the minds of men from the little Red School House. Varsity First, Faculty Second, has been, and should ever be, our motto.

Despite the fact that so many of our men have been playing on University teams, School has been very successful in the interfaculty contest. Five championship cups will rest for another year with us, namely, Track, both outdoor and indoor; Soccer, Swimming and Water Polo.

Our Senior School Hockey team won their group in the Jennings Cup series, and went down to defeat to the Victoria team, the champions, after a hard battle. In Rugby, neither team were able to win out in their groups, but both teams played good Rugby. Our Indoor Baseball team are still in the running for the championship, and look like winners. The Junior School Basketball team have won their group and look like real contenders for the Sifton Cup.

The Athletic Executive have been very much helped this year in carrying out their work by the bringing into effect last year of a compulsory athletic fee of $1.00 per annum. F. R. McDonald and his executive of last year are to be complimented very highly on putting this through, as it has done away with many former difficulties.

School this year boasts of five captains of University teams—K. L. Carruthers of the Track; R. H. Keefler of the Swimming; G. G. Duncan of the Rugby; R. J. Williamson of the Gym. team, and G. L. McGee, of th eRowing Crews.

In closing, on behalf of the executive for 1921-22, I wish to thank you all for your support this year and to wish you all much success for the coming and future years.

W. BEATTIE RAMSAY,
President Athletic Association.

## Rugby.

By Gordon Duncan, Captain Varsity I.

In the words of "Transactions, 1921," we have: "The success of last year's Varsity team was largely due to the capable coaching of Laddie Cassells." This year we need only substitute the name of "Jack" Maynard, and we are correct to the seventh decimal place. "Jack" certainly gave all he had in the interests of the team.

Though not as successful as last year, the Senior team came through with the Intercollegiate championship, partly through the brilliant feat of holding McGill to a 4-4 tie game at Montreal, and partly through the generosity of Queen's in thrashing McGill in Kingston. Queen's were the surprise of the league, winning both home games and losing here a hard-fought game 13-12.

After another thrilling battle Varsity was forced to hand over to the Argonauts the Earl Grey Cup, emblematic of the Canadian Senior Rugby Championship. Many of the seventeen thousand who saw the game have stated that the score, 20-12, does not indicate the relative strength of the two teams.

The prospects for the coming season are very bright. The choice of Harry Hobbs for captain is a very popular one throughout the University. The team loses by graduation two brilliant outside wings in Frank Fisher and Perlman, as well as the services of Keith Carruthers, who played a great game against Argonauts.

Varsity seconds, under the leadership of Doug. Catto, also of School, deserve our sincere congratulations on retaining the Intermediate Intercollegiate Championship. Too much credit cannot be given to the second team for their unselfish work during the Rugby season. They take the bumps night after night in practice games with the Seniors, and incidentally put up a great battle, quite unnoticed by the University at large. It is quite probable that the second team will be entered in the Senior O. R. F. U. series in future. This should do a great deal towards encouraging interfaculty players to turn out for this team.

In the Mulock Cup series, both Senior and Junior "School" teams lost out. True, the group winners from Senior School's part of the league won the cup, but even so, School seems to lack something. This cannot be due to the lack of good material at S. P. S., of which there is an abundance; but rather to lack of regular practices. In order to win the Mulock Cup it is necessary for all the Rugby players in "School" to turn out regularly and fight for positions on their teams. How about Senior and Junior School for the Mulock Cup finals next year?

# HOCKEY.

By W. Beattie Ramsay, ex-Captain Varsity I.

IN some ways the past season, as far as the senior University team is concerned, has been disappointing. After the success of last year, when our team went through to the Dominion Championship, winning the Allan Cup, everyone looked for another big year. The team, with the exception of Sullivan and Olson, was intact from the previous year.

The season started with the S.P.A. series, and the Varsity team came through it, defeating Granites, Kitchener, and Argos. The successful tour of the States followed this, and the team came home winning seven straight victories from the best that Uncle Sam could produce.

The O.H.A. senior series then opened, and the Argos were defeated by an overwhelming score. Next came the Granites, and that long-to-be-remembered 30-minute-overtime game, from which the Granites emerged victorious. It was at this point that the Varsity "slump" started, and three successive games were lost to Aura Lee, Kitchener, and a second to Granites. Many articles have been written on the slump, but I, personally, think the break came in that first Granite game. Carson, our star centre man, played 85 of the 90 minutes that night, and never recovered from the gruelling he received for three weeks, on top of which he received severe injuries in both the Queen's games. Stan. Brown, the lightning defence man, received injuries in the S.P.A. series from which he did not recover fully for a month. This took away a great deal from the effectiveness of our attack.

In the Intercollegiate series every game was won by Varsity. School had two representatives, Ramsay and Evans, on the senior team.

The Intermediates were defeated in their group in the O.H.A. and also in the Intercollegiate series. School were not represented on this team.

The Juniors were also defeated in their group in the O.H.A. and also in the Junior Intercollegiate. Dickenson was the only representative from School on this team.

In the Jennings Cup series Senior School won their group but later went down to defeat to the championship Victoria College team, after a hard struggle.

S.P.S.

SACCER

TEAM

(Interfaculty
Champions)

Top Row—

J. Maclellan
J. H. Browne
L. D. Campbell
R. H. Cooke

Middle Row—

M. Meikle
E. S. Lecroyd
Prof. C.H.C. Wright
(Hon. Pres.)
C. P. Bruels
G. D. Scott

Bottom Row—

S. S. Smillie (Mgr.)
W. R. Dunbar
H. E. Wingfield
C. H. Lucas (Capt.)
W. V. Bishop

## Soccer.

By S. W. Archibald, Pres. Association Football Club.

At the commencement of the Soccer season, 1921, Varsity Firsts, Seconds and School interfaculty champions had exactly the same teams available as last year. Several men who had played well in the interfaculty and seconds were out for a place on the Firsts and Dents, Victoria, and O. A. C. were each determined to relieve School of the Faculty Cup.

There was considerably more interest shown than in previous years, and the twelve Interfaculty teams entered were divided into three groups. O. A. C., who entered the Interfaculty as well as the Intermediate series, was given a bye until the semi-finals, when they met the winners of Group three. The semi-finals brought School vs. Dents, and both teams entered the series confident of winning, and feeling ran high after the first game resulted in a no-score draw. The second game was won by School 2-1, but was protested, Dents claiming a goal when the ball was deflected into School's goal off a spectator. The referee declared no goal on the field. The protest was allowed by a committee of the executive, and ordered re-played. School played under protest, and on a very slippery field lost 1-0. School's protest was considered by the Athletic directorate, which threw out the last game on the ground that regulations had not been followed in dealing with the first protest, and further upheld the referee's decision, giving School the right to meet O. A. C., who had disposed of Victoria in the finals. By beating O. A. C. here and holding them to a draw at Guelph, School kept the Faculty Cup for another year.

During the season two School men, Glover, centre half, and Bishop, centre forward, went to the first team and made good. School had five men on the First team, which won the Intercollegiate from Queen's quite easily, and although they didn't qualify in time to get on the T. and D. schedule, played an exhibition game with the British Imperials and won a closely-contested, well-played match. This was the first break of University soccer into city football, and next year should see Varsity well up in the T. and D. Efforts are also being made to strengthen the Intercollegiate series. The second team, composed largely of School's Interfaculty champions, won the series from McMaster and O. A. C.

Next year most of the School players will be back, and with "Red" Wingfield, president of the University Soccer Club, a most successful season may be looked forward to.

S.P.S. TRACK CHAMPIONS

Standing—E. F. Connolly, W. L. Thompson, G. Rumble.

Sitting—A. A. Bell (Captain), K. L. Carruthers (Individual Champion), G. B. Langford.

## Track.

By Keith L. Carruthers, Varsity Captain.

In introducing the subject of track, need we mention that School retains the Cricket Club Cup for the third successive year, and are already well on the road to their third indoor championship. That is an enviable record, and it is up to School men in the future to keep up the good work, even should it seem to become monotonous.

In the interfaculty meet in the fall we were provided with little opposition. Our three giants, Bell, Langford and Carruthers, won all the points in the three weight events; Rumble came through with a win in the 220 yards; Thompson the same in the mile; Carruthers the hurdles, and Turner did well in the jumps. Carruthers, the Varsity captain, broke two records for School in the discus and the hurdles.

The indoor meet, though just fairly under way, shows School predominant in the field events and sprints, and that should in itself be enough to win the championship. We have so far won the 50, 220, 440 and half-mile, as well as the high jump and the shot. We should win four of the seven events left, and there you are. Evans and Boake are new discoveries.

The Intercollegiate meet, however, resulted in a third straight win for McGill. Unless we develop a sprinter or so who can do 10 1-5 or better we will never win. That sounds pessimistic, but McGill will win first and second in all the sprints until such is the case. Surely out of a large University like this we can find one man who can sprint a little bit. Such is not the case now.

Varsity won the three miles, with McAuliffe breaking the record; the high jump, the broad jump, the pole vault, hurdles, and discus, Carruthers breaking a record in the latter. The hurdles were run in the darkness, and this undoubtedly prevented a new record being hung up. Look out for Lanky Rowell in it next year, however.

## Harrier.

By Keith L. Carruthers.

Ontario Agricultural College came down with a well-balanced team and took from Meds the Harrier championship. None of their men were stars, however, so on their departure for the Intercollegiate race at Kingston we find the Varsity team composed of McAuliffe, Leigh, Bell, Stevenson and Craigie, none of whom had the fortune of coming from S. P. S.

At Kingston Varsity made almost a joke of the race, our men running 1, 2, 3 and 4, well ahead of all other competitors. In fact, number three and four worked it so that they crossed the line together, thus qualifying for their "T." This is a championship which we should retain for some time, as apparently no one can approach us at distances over a mile. Here's hoping!

S.P.S. WATER POLO TEAM—Eckhardt Cup Champions

Standing—C. A. Booth, B. C. Watson, A. A. Bell, E. E. Schinbein, A. N. Conklin.
Sitting—A. M. Fitzgerald, R. H. Keefler, G. E. Lindsay (Manager), J. C. Harston (Captain), C. M. Wells.

## WATER POLO.

By C. A. Harston, School Captain.

THE School Water Polo team went into the game this season with the intention of bringing the Eckhardt Cup back "home." The team did it, and went one better, going through the double schedule of the Intrefaculty Series without a defeat. There were no weak points in the team. With "Slim" Bell in goal, and Conklin and Schinbein on the defence, the opposing forwards stood but a poor chance of getting the ball into the net; this point is emphasized by the fact that only four goals were scored against the team during the whole season.

The forward line, consisting of Wells, Harston, Fitzgerald, Keefler and Matson (three at a time), were as hard to stop as the defence were hard to beat. The heaviest, hardest game of the season was played against an all-star team from the rest of the University, when the score stood 3-3 at the end of the regulation time.

The team played real water polo all year, and was the star attraction at Hart House tank during the series, as was evidenced by the crowded galleries of both sexes at all the games in which School played. All honor to them!

The first of the home-and-home games with McGill was held in Montreal. Our team, consisting of five School men, one Arts man, and two Dents, were held scoreless, while McGill netted two. This left us with a handicap of two goals to overcome on the return game here. For seventeen of the twenty minutes Varsity had the ball in McGill territory, but were unlucky with their shots. The final score of 1-0 gave McGill the round, 2-1. Varsity scored another goal, which was disallowed.

## Rowing.

By Keith L. Carruthers.

Varsity is well out in front in rowing nowadays, and her eight-oared crews on which she specializes are found in "Who's Who" for Canada. All through the winter of '20-'21 the boys trained faithfully on the machines in Hart House under the able coaching of "Tommy" Loudon, of "School," and President Frank Spence and Captain "Les" McGee, of the Rowing Club. Need we state that these last two are School men also?

Early in April the old members renewed acquaintanceship with their shell, and the men who were new to the game had their first frightened look over the side of a working boat. The only race for three months was at the Dominion Day Regatta, when our tack-weight crew came second.

S.P.S. SWIMMING TEAM—Fitzgerald Cup Champions

Top Row—A. N. Conklin, C. G. Kingsmill, E. E. Schinbein, R. B. Kerr, C. A. Booth.
Bottom Row—J. C. Harston, R. H. Keefler, G. E. Lindsay (Manager), C. M. Wells (Captain). A. M. Fitzgerald.
Absent—M. D. Ross, G. C. Mutch.

The Canadian Henley, held four months after our crews took to the water, supplied the first races for the heavy crews. The first day our Junior crew, averaging 172 pounds per man, won easily over Argos, Detroit, Lachine and Hamilton. The tacks followed in second place in their race, Detroit leading them to the winning post. On the final day it was a grand sight to see our Senior and former Junior crews rowing one two for the Senior Championship of Canada and the retention of the Hanlan Memorial Trophy.

The rowing of the crews was so satisfactory that subscriptions were raised to take the Senior and Junior crews to the National Regatta at Buffalo. The first day the Junior crew rowed in the intermediate race, and the supremacy of Tommy Loudon's coaching was easily proved by a nice victory over New York A. C., Duluth, Detroit, Vespers, Nortons and Worcester. The final day both Varsity crews entered the Senior race. A terrific storm was beating in from Lake Erie at the time, but regardless of this the race started. The former Junior crew, profiting by their win of the day before, jumped at the gun and gained a length on the field. Unluckily a break in the breakwater let in enough waves to swamp partially their light boat, and they left the Seniors to battle it out. Though handicapped by the backwash found in an inside position, our Seniors came within two feet of the American Senior Championship.

The tack-weight crew consisted of Tufford, of Meds, and the remainder "School" men, namely, Johnson, McGee, Keefler, Williams, McQueen, Seaborne, Sirrs, Hamilton and Baxter.

The Seniors had Little, Smith, Bell, Huestis and Peterkin, of S. P. S., and Campbell, Coventry, Beatty and Creighton to help out. The Juniors had Carruthers and Smart, of S. P. S., plus Wallace, Jackson, Langford, Taylor, Malley, Morris and Croll.

The chances for this year are very bright. For a new Junior crew, fifty or so six-footers are turning out three times a week to pull the machines almost out of Hart House. The Senior crew will be picked from the best of last year's two crews. The club hopes to row somewhere this year, Parkdale C. C. being the place highest in favor at present. The building of a working boat is occupying most of the club members just now in the basement of the School of Science.

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## SWIMMING.

By R. H. Keefler, Varsity Captain.

THE past season has been undoubtedly the most successful yet experienced by the sterling swimmers from the Little Red Schoolhouse. After a term of strenuous training the S.P.S. team, for the third successive year, captured the honors in the Interfaculty Swimming Meet, thus retaining the Fitzgerald Cup.

The Interfaculty Meet was the closest in years. Curtis Wells won the 200 yards; Fitzgerald the 50 yard breast stroke; Keefler won the 100 yard sprint and came second in the 50 yard; Harston got third in the 100 yard race. Arts, with Ruddy and Waldron starring, kept pace, however, as far as points were concerned, and when the relay race was called, Arts led by 5 points.

As there were seven teams entered, two heats were necessary, the times taken to count. The School first team won the first heat handily with Arts in third place. Then our second team won the second heat in time good enough to give them fourth place. As first place gave eight points and fourth place one, while third meant three, the end of the meet found School leading 28-27.

At Montreal Varsity repeated their success of two years ago by winning the relay and, "incidentally," as a result, the meet, the other events being so close as to practically deadlock the rival teams. Wells won the 200 yard race; Keefler won two seconds in the 50 and 100 yard sprints; Fitzgerald came second in the 50 yard breast stroke, and three of the relay team were School men.

The following men took part in the various Interfaculty events for School: Wells III., Harston III., Booth I., Keefler II., Fitzgerald III., Conklin III., Schinbein III., Kingsmill II., Kerr II., Murray III., and Mutch III.

## BOXING, WRESTLING AND FENCING, 1921-22.

By F. Seaborne, Secretary, B. F. & W. Club.

THE Faculty of Applied Science has, for the past three years, felt that the proper place for the Davidson Cup is within the walls of the "Old Red School."

We have the men,
We had the opportunity,
But—where is the cup?

The fault, I believe, lies with the two junior years. Senior men can not be expected to carry on for ever. True, there are a few who have found time to battle on even in their final year. They are the exception, not the rule.

We can not, halfheartedly, enter into competition with such worthy opponents of mitt and steel, as O.A.C. have proven themselves to be, and escape with the "tinware" unscathed.

In the Junior Meet this year, School was barely represented. Of the twelve School entries, seven were from the third year, leaving three entries from the first year and two from the second year. The total entry list from all faculties numbered 124. Had it not been for the efforts of W. S. Maguire, a third year miner, we would have had no one come through this meet undefeated. Maguire has trained consistently for the past three years and succeeded this year not only in winning the Junior 135 pound Boxing but entered and won the same class in the Senior Assault.

In the Senior Assault, we depended almost entirely upon a few "Old Reliables" and in spite of being poorly supported they carried School along, and though the "Aggies" are now polishing the Davidson Trophy the few men who represented S.P.S. may well be proud of their third place.

O. A. C. came down with a small army of boxers and wrestlers—two men in each weight—and demonstrated that the best way to get anything is to go after it, and that you cannot hope to win a class unless you enter it.

In the Senior Assault-At-Arms, Lavender—of the second year—carved his way to third place in the Fencing, and deserves great credit for so doing as all the fencing bouts are keenly contested and the first and second places went to Walton, Forestry, and Hewitt, U.C., who hold the Intercollegiate championship for '20-'21 and '21-'22.

In Wrestling, Harry Oaks, a fourth year man, battled two extra rounds before the bout was awarded to Adams of Dentistry. Adams holds the 135-pound Intercollegiate Wrestling for '20-'21 and '21-'22, but was unable to take a fall out of "our Harry." Oaks is an asset to any team and it is to be regretted that he leaves us this year.

In Boxing, Schemnitz, another fourth year man, won the 125 pound class in both the Senior Interfaculty and the Intercollegiate. "Shimmie" has worked hard and consistently for three years and all of us who know him rejoice at his success and wish we had a few more like him.

Maguire, who deserves great credit for his determination, succeeded in winning the 135 lb. Senior Interfaculty, but was later unplaced from the Intercollegiate team by "Goldie" Gray who is, unfortunately, a "Med."

We hope "Maggie" will be able to find time to turn out next year and we are confident that it will be no fault of his if he does not help bring another championship back to School.

Jack Goldie, the 175-pound terror, defended his title in both the Senior Interfaculty and Intercollegiate with marked success. We feared at one time that Jack would not be able to participate as he had injured his shoulder this past season, playing Rugby for Senior School. However his one-ton wallop proved as effective as ever and he remains at the top of the 175's.

These men have one and all devoted a great deal of their time to bringing honor to S.P.S., and those who remain with us next year are deserving of more support from their Toike Oike brotherhood. There once was a time when the School banner bore the time-honored motto: "Upguard et at 'em et soc et tu 'em," and it brought results.

## BASKETBALL.

By Keith L. Carruthers.

BASKETBALL did not agree with Varsity this year, or vice versa, and we find the Intercollegiate laurels resting at McGill for the next twelve months. At the beginning of the season, the team toured the States both before and after Christmas. They did quite well, winning slightly over half their games, most of which were against strong University teams.

Following this, they gave a fine display in their home games against McGill and Queen's, winning both rather easily. Whether this gave them an impression that "all was right with the world" is hard to judge, but in the return games Queen's romped away from them at Kingston, and McGill nosed them out in the last minute at Montreal, giving McGill the title. Either Varsity eased up or the other teams showed a startling reversal of form from their Hart House efforts.

Senior School played fine Basketball in their group for the first three or four games, then they lost a close game to Victoria. This tied the group up, as both had beaten Senior Arts and Senior Dents twice. In the play-off, School were decidedly off color and took the short end of a 13-7 score. It was unfortunate that a slump appeared at a critical time.

In their group, however, the Junior School team came through in fine style, without a loss. At the moment of writing they are playing in the semi-finals with Junior Dents for the honor of representing their Faculty in the finals. In Turner, at centre, and Lloyd, on the forward line, the Junior School team have two great finds who ought to do themselves and School even more justice as time goes on.

Both of these players are on the Varsity Junior team, which has done very well this year, just being nosed out in the City League. On the Senior team we find only one School man, Duffil, who is one of the cleverest of guards and is certainly not the weakest man on the team.

Better luck next year, Varsity, and the same to you, Senior School gallants.

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## Gymnasium Work.

By M. H. Wolsey, Team Manager.

It seems characteristic of School men to have a good representation in every line of sport. They are not to be found lagging, even when it comes to gymnasium work. This line of activity usually has a very poor following on account of the slowness with which any advancement is made, and the fact that it takes a great deal of time and patience.

Of late years there have been quite a few gymnasts of note, but it remained with a small group of School and Medical men to form a University team. The outcome of this was an Intercollegiate competition last year, resulting in the team carrying off the honors on home ground. One-half of the team was composed of School men, namely, R. J. Williamson, S. Williams and M. Wolsey. These men do not include th emany School men who turned out regularly for the work.

All the School men taking up this work, assisted by D. Heustis, gave an exhibition number at the inaugural night of "Spasms," where they demonstrated the character of the work on the high bar. The act was received very favorably, and stimulated the "cause" around the University.

At the time of writing this article the team for this year's meet has not yet been chosen. But as more than three-quarters of those turning out are School men and our captain for the year is R. J. Williamson—well, every indication points to School having a great deal to say again this year.

It is the old School spirit, and it is up to those following to keep up the good work. It is a major sport; "T's" are granted for it, and the physical development derived from participation in gymn. work is most beneficial. It is a line of activity not to be despised, and worthy of School men, calling for good condition, self-control, nerve and strength of arm.

## INDOOR BASEBALL.

By W. L. Yack, Manager Senior School Team.

SCHOOL seems to keep knocking at the door each year in this sport, new to Varsity, but so far we have been unlucky. Junior School met defeat rather early in their group, but in group C, three of the four teams were very evenly matched. Two years in succession, Senior School have tied up their group, only to lose out in the play-off.

This year they lost the first game in their group, only to put on a burst and tie it up. With one game to play each, Dents, School and Trinity tied for first place. It took five games for Senior Dents to eliminate Senior School. Dents won two, lost one, and tied two games. In spite of their defeat, Senior School had on their team the two best pitchers in the league in Mummery and Mutch. Mummery, who is probably the speedier of the two, lost a lot of his effectiveness by the introduction of the third strike rule. Our catcher was unable to hold him, though Doran played very well in trying circumstances. The standing of Group C at the time of writing, with School definitely eliminated, is:

| | | |
|---|---|---|
| Dents | won 6 | lost 3 |
| Trinity | won 6 | lost 3 |
| School | won 5 | lost 4 |
| Arts | won 1 | lost 8 |

The Senior School team had the following members during the season: C. R. Mummery, G. Mutch, H. Westren, A. Fitzgerald, W. Fitzgerald, J. Doran, W. Benson, J. McAllister, A. A. Bell, and W. L. Yack.

## TENNIS.

By E. M. Little, Vice-President Tennis Club.

THE Undergraduate Tennis Tournament was held in the early part of October on the excellent courts of the Toronto Tennis Club. There were approximately one hundred entries, and owing to the good weather and the splendid manner in which the tournament was handled, it was run off in record time. W. Guillet won the singles tournament while Scott, Larkin, Banbury and Ham also qualified for the team. In the challenge round, however, Ham was eliminated by Burrowes.

McGill, in a letter to the athletic directorate, intimated their desire to have the Intercollegiate tournament played during their big Centennial Celebration Week. Unfortunately, it was impossible, owing to the large number of entries, to complete the tournament and decide the team in time to comply with their wish. Queen's, however, were in a position to play at that date, but were defeated by McGill. The following week the Varsity team went to Montreal, but were defeated by McGill, Scott, of the Meds, being the only man to win points for Varsity.

McGill will quite possibly have a stronger team in the tournament next year than this, so all Tennis players are requested to enter the local tournament so that Varsity will be able to put the strongest possible team in the field. This especially applies to School men, who are conspicuous by their absence in the Tennis tournaments these days.

## Squash.

By T. S. Glover.

This game is one in which the undergraduate body has but a passing interest, for obvious reasons. First, we have only three courts for the whole Varsity, which means that only six men can play each half-hour of the day. Now the budding Engineer is called upon by a stony-hearted Staff to toil from early morn to twilight, or more definitely, 5 p.m. At this hour the courts are most in demand, and since one is only allowed to book a court a day in advance, many are disappointed daily.

Then, too, the galleries accommodate only about ten spectators for each court, so that those who wish to lean over the coping and hurl encouraging remarks at the almost naked combatants are not always able to gratify their desires.

However, of the comparatively small number of men actively interested in the game, we supply a goodly number, of the usual School quality. Chief amongst these is Steve Greey, who has not yet succeeded in claiming the dizzy eminence of "top of the list," but in whose ability ultimately to do this we trust implicitly. It is only right and proper that this exalted position should be held by a School man. Hugh Lawson, one of last year's star turns, has unfortunately been laid up with a game leg, a present from Fritz.

It is encouraging to note that many newcomers have with a whoop and a yell descended on the courts—all as it should be. This is the only way in which we can secure the first twenty places on the tournament board, and we cannot be satisfied with less than that.

In a series of matches between the University Club and two Varsity teams of five men each, our opponents managed to beat us without undue effort—a condition of affairs we hope to see reversed before next season is over. We therefore exhort and encourage all true and loyal men to get into the game and work at it.

## "T" HOLDERS OF S.P.S.

| | |
|---|---|
| F. W. Baldwin, '06 | 1903 R. |
| P. A. Laing, '05 | 1903 R. |
| P. V. Jermyn, '04 | 1903 R. |
| H. E. Beatty | 1903 R. |
| L. D. Young | 1903 R. |
| C. Johnson, '06 | 1903 R. |
| M. B. Bonnell, '04 | 1903 R. |
| W. C. Cochrane | 1903 R. |
| R. R. Bryce | 1903 R. |
| A. L. McLennan | 1903 R. |
| F. W. Burnham | 1906 R. |
| G. B. Reynolds | 1904 R. |
| W. R. Worthington, '04 | 1904 T. |
| E. W. Archibald | 1904 C. |
| W. Barber, '05 | 1904 T. |
| C. Johnson, '06 | 1905 R. |
| K. G. Ross, '06 | 1905 R. |
| F. C. Broadfoot, '06 | 1905 H. |
| F. F. Montague, '06 | 1905 H., R. |
| C. G. Toms, '08 | 1905 H. |
| W. C. Blackwood, '06 | 1906 S. |
| J. M. McInnes | 1906 R. |
| H. C. Ritchie, '10 | 1906 R. |
| H. Clarke | 1906 H. |
| K. Hall, '07 | 1907 R. |
| M. E. Nasmith, '08 | 1907 R. |
| C. W. Powers | 1907 R. |
| J. A. D. McCurdy, '07 | 1907 R. |
| E. W. Murray, '07 | 1907 R. |
| M. Pequenat, '08 | 1907 S. |
| W. H. Young, '05 | 1907 S. |
| H. C. Davis, '09 | 1907 T. |
| J. Van Nostrand, '09 | 1907 T. |
| J. H. Adams, '10 | 1907 T. |
| J. Newton, '09 | 1907 R. |
| H. G. Kennedy, '08 | 1907 R. |
| H. Gall, '10 | 1907 R. |
| W. S. Coryell | 1907 R. |
| A. D. Huether, '08 | 1907 R. |
| W. E. V. Shaw, '08 | 1907 R. |
| L. A. Wright, '10 | 1907 T. |
| G. E. Woodley, '10 | 1907 T. |
| J. P. Charlebois | 1907 T. |
| J. I. McStoy, '10 | 1907 T. |
| A. D. Campbell, '10 | 1907 L. |
| C. A. Grassie, '08 | 1907 S. |
| H. R. Carscallen, '08 | 1908 S. |
| F. Y. McEachren | 1908 Ten. |
| C. P. Sills, '11 | 1908 S. |
| G. A. Kingstone, '10 | 1909 R. |
| A. E. Duncanson | 1909 R. |
| J. A. Macdonald, '10 | 1909 R. |
| C. F. Elliot, '11 | 1909 R. |
| A. W. Pae, '09 | 1909 Box. |
| H. H. R. Macdonald | 1909 Box. |
| W. E. Doherty | 1909 Box. |
| A. M. McKenzie, '14 | 1909 Sw. |
| C. Johnson, '09 | 1909 Sw. |

**S.P.S.**

**T-HOLDERS**

Top Row (L. to R.)

A. A. Bell
G. E. Lindsay
C. M. Wells
K. L. Carruthers
J. E. Goldie
S. Williams

Middle Row—

G. G. Duncan
W. H. Duffil
S. S. Smillie
Prof. C. H. C. Wright, R.A.
M. Wolsey
F. S. Seaborne
G. F. Evans
A. W. Carew

Bottom Row—

T. S. Glover
W. S. Sherk
R. J. Williamson
W. B. Ramsay
G. W. Smart
R. C. Relyea
J. C. Perry

Inserts—

F. C. A. Houston
M. F. Johnson
W. V. Bishop
M. G. Evans
E. G. Rolph

| | |
|---|---|
| C. E. Gage, '18 | 1909 R, B., Box. |
| R. B. Chandler, '11 | 1907 T. |
| E. M. Watts | 1909 T. |
| J. M. Gibson, '10 | 1909 T. |
| J. D. Cummings | 1909 Ten. |
| W. C. Foulds, '10 | 1909 R. |
| W. H. Wylie, '11 | 1910 S. |
| F. A. Lee | 1907 R. |
| C. E. Richardson, '10 | 1910 H. |
| A. Code | 1910 H. |
| T. F. Lamb | 1910 S. |
| F. T. Nichol, '10 | 1910 G. |
| G. R. Workman, '10 | 1910 G. |
| M. M. Gibson, '10 | 1911 Box. |
| R. F. Davison | 1911 Box. |
| R. S. Dobbin, '10 | 1911 B. |
| I. R. Strome, '14 | 1911 H. |
| J. J. Phillips, '13 | 1911 T. |
| G. R. Elliot, '11 | 1911 Har. |
| G. B. Taylor | 1911 R. |
| C. E. Macdonald, '18 | 1911 R. |
| R. S. Bell, '13 | 1911 R. |
| W. T. Curtis, '13 | 1911 R. |
| A. M. German, '13 | 1911 H, R. |
| R. Sinclair, '15 | 1911 R. |
| E. Greene, '13 | 1911 R. |
| H. D. Davison, '13 | 1911 G. |
| P. S. G. Campbell | 1911 R. |
| D. A. McKenzie, '13 | 1912 W. |
| D. A. Mutch, '13 | 1912 Box. |
| W. B. Caldwell, '13 | 1912 H. |
| H. Webster, '13 | 1912 H. |
| F. F. Foote, '13 | 1912 Sw. |
| L. B. Tillson, '15 | 1912 Sw. |
| E. A. Twidale, '14 | 1912 T. |
| N. H. Lorimer, '14 | 1912 R. |
| L. R. Brown, '19 | 1912 R. |
| D. B. Gardner, '16 | 1912 R. |
| W. H. MacTavish, '13 | 1913 S. |
| C. E. Sinclair, '14 | 1913 H. |
| L. Simpson | 1913 B. |
| G. E. Clarkson, '13 | 1913 H. |
| G. Rankin, '15 | 1913 Box. |
| D. Blain, '13 | 1913 G. |
| F. S. Rutherford, '14 | 1913 P. |
| B. N. Simpson, '14 | 1913 P. |
| M. Levy | 1913 Box. |
| K. C. Burness | 1913 T. |
| V. R. Pfrimmer | 1913 S. |
| G. Blackstock | 1913 R. |
| E. H. Jupp, '15 | 1913 H. |
| J. P. Cavers | 1914 Box. |
| C. C. Anderson, '18 | 1914 F. |
| H. M. Campbell, '14 | 1914 F. |
| A. R. Mendizabal, '18 | 1914 G. |
| R. T. Carlyle, '14 | 1914 Sw. |
| R. H. Huestis, '20 | 1914 G, Row. |
| F. Bryans | 1914 R. |
| W. O'Reilly | 1914 R. |
| C. A. Hughes, '20 | 1914 R. |
| L. S. Adlard, '15 | 1914 R. |
| S. M. Peterkin, '15 | 1914 R, Row. |
| J. R. Gilley | 1914 S. |
| R. G. Scott, '15 | 1914 S. |
| G. D. Gray, '15 | 1914 S. |
| J. L. Skinner, '16 | 1915 Har. |
| A. N. Burwash | 1915 Har. |
| C. E. Oliver, '16 | 1915 F. |
| J. Gray, '15 | 1915 W. |
| J. Ross, '15 | 1915 W. |
| H. Kohl, '15 | 1915 W. |
| E. R. Gilley, '20 | 1917 B. |
| J. S. Wilson, '20 | 1915 H. |
| E. R. Dafoe, '20 | 1915 H. |
| C. Smythe, '20 | 1915 H. |
| H. M. Peck, '15 | 1915 Sw. |
| J. R. Mitchener | 1915 G. |
| G. R. Gouinlock, '21 | 1915 H. |
| E. Birdsall, '20 | 1915 R. |
| M. S. Taylor | 1915 R. |
| L. W. Ross | 1916 W. |
| W. J. Nichol, '20 | 1916 H. |
| J. L. Levesque, '17 | 1916 H. |
| E. W. Smithson, '17 | 1917 R. |
| L. R. Shoebottom, '20 | 1916 R. |
| H. S. Spencer, '21 | 1917 Ten. |
| A. B. Harris, '17 | 1916 R. |
| G. P. Pearson, '18 | 1917 H. |
| D. G. Scott | 1917 H. |
| F. C. A. Houston, '22 | 1918 R. |
| S. H. Johnston, '19 | 1919 H. |
| W. B. McIntyre, '21 | 1919 H. |
| W. B. Ramsay, '22 | 1915 H. |
| K. L. Carruthers, '22 | 1919 T, R., Row. |
| J. M. Breen, '21 | 1920 R. |
| F. G. Sullivan | 1920 R, H. |
| G. G. Duncan, '23 | 1920 R. |
| W. S. Sherk, '22 | 1920 W. |
| J. C. Perry, '22 | 1920 W. |
| O. D. Vaughn, '20 | 1920 F. |
| F. S. Seaborne, '23 | 1920 Box. |
| P. F. McIntyre, '21 | 1920 H. |
| G. F. Evans, '23 | 1920 H. |
| G. E. Lindsay, '23 | 1920 Sw. |
| A. A. Bell, '23 | 1920 Row. |
| J. D. Smith, '25 | 1920 Row. |
| G. C. Bennett, '20 | 1920 Row. |
| H. B. Little, '20 | 1920 Row. |
| G. L. McGee, '21 | 1920 Row. |
| J. B. Hamilton, '21 | 1920 Row. |
| E. G. Rolph, '23 | 1921 R. |
| M. D. Earle | 1921 R. |
| A. W. Carew, '23 | 1921 R. |
| S. S. Smillie, '22 | 1921 S. |
| S. Williams, '22 | 1921 G. |
| M. H. H. Wolsey, '23 | 1921 G. |
| R. J. Williamson, '22 | 1921 G. |
| R. C. Relyea, '23 | 1921 Box. |
| W. H. Duffill, '23 | 1921 B. |
| J. E. Goldie, '23 | 1921 Box. |
| C. M. Wells, '23 | 1921 Sw. |
| W. Turner, '25 | 1921 T. |

| | |
|---|---|
| M. G. Evans, '23 | 1921 S. |
| T. S. Glover, '22 | 1921 S. |
| W. F. Johnston, '23 | 1921 S. |
| W. N. Bishop, '22 | 1921 S. |
| H. E. Firth, '24 | 1922 L. |
| W. E. Douglas, '98 | 1922 Row. |
| T. Burnside, '98 | 1922 Row. |
| R. H. Keefler, '24 | 1922 Sw. |
| A. M. Fitzgerald, '23 | 1922 Sw. |
| J. C. Harston, 23 | 1922 Sw. |

Total 190, or about one-third of all granted, arranged according to sequence of granting.

NOTE: R—Rugby; T—Track; C—Cricket; H—Hockey; S—Soccer; L—Lacrosse; Ten—Tennis; Box—Boxing; Sw—Swimming; G—Gymnastics; Har—Harrier; F—Fencing; P—Water Polo; Row—Rowing; W—Wrestling; B—Basketball.

## UNIVERSITY OF TORONTO ENGINEERING SOCIETY TRADING ACCOUNT

### For Twelve Months Ending March 31st, 1922

| | | |
|---|---|---|
| Sales | | $16,764.29 |
| Inventory, March 31st, 1921 | $ 2,200.00 | |
| Merchandise purchased | 14,465.34 | |
| | $16,665.34 | |
| Less Merchandise on hand | 2,450.00 | |
| | $14,215.34 | |
| Gross Profit to Profit and Loss Account | 2,548.95 | |
| | $16,764.29 | $16,764.29 |

## PROFIT AND LOSS ACCOUNT

### For Twelve Months Ending March 31st, 1922

| | | |
|---|---|---|
| To Salaries | $ 780.00 | |
| " General Expense | 902.43 | |
| " Alumni Re-Union | 39.35 | |
| " Spasms | 757.75 | |
| " Dinner | 702.41 | |
| " Orchestra | 25.00 | |
| " Dance | 999.01 | |
| " Grants to Affiliated Clubs | 53.50 | |
| | | $4,259.45 |
| Net Profit to Capital Account | | 2,278.22 |
| | | $6,537.67 |
| By Gross Profit from Trading Account | $2,548.95 | |
| " Fees | 1,600.00 | |
| " Sale of Caps | 10.75 | |
| " Interest and Discount | 50.37 | |
| " Spasms | 669.60 | |
| " Dinner | 590.00 | |
| " Dance | 1,068.00 | |
| | | $6,537.67 |
| | | $6,537.67 |

## UNIVERSITY OF TORONTO ENGINEERING SOCIETY BALANCE SHEET

### For Twelve Months Ending March 31st, 1922

### ASSETS

| | | | |
|---|---|---|---|
| Current | | | $7,694.91 |
| Cash | $ 269.12 | | |
| Bank, Current | 1,351.67 | | |
| Bank, Savings | 2,500.00 | | |
| | | $4,120.79 | |
| Victory Bonds | | 1,000.00 | |

| | | | |
|---|---|---|---|
| Accounts Receivable | $369.75 | | |
| Less—Reserve for Doubtful Debts | 245.63 | | |
| | | 124.12 | |
| Merchandise on hand | | 2,450.00 | |
| | | $7,694.91 | |
| Fixed | | | 634.29 |
| Office Equipment | $624.29 | | |
| Less—Reserve for Depreciation | 40.00 | | |
| | | $584.29 | |
| Smoking Room Furniture | $70.00 | | |
| Less—Reserve for Depreciation | 20.00 | | |
| | | 50.00 | |
| | | $634.29 | |
| | | | $8,329.20 |

## LIABILITIES

| | | | |
|---|---|---|---|
| Current | | | $1,245.25 |
| Accounts Payable | | $1,245.25 | |
| | | $1,245.25 | |
| Deferred | | | 120.28 |
| Debating Club Trust | $ 8.90 | | |
| Suspense | 23.36 | | |
| Publications | 88.02 | | |
| | | $120.28 | |
| | | $120.28 | |
| Liability to Engineering Society | | | 6,963.67 |
| Capital Account | $4,685.45 | | |
| Net Profit from Profit and Loss | 2,278.22 | | |
| | | $6,963.67 | |
| | | $6,963.67 | |
| | | | $8,329.20 |

A. ROSS GILCHRIST,
Accountant.

### Expenditures to be Made During April, 1922

| | | | |
|---|---|---|---|
| From Net Profit | | | $2,278.22 |
| To Net Cost Publishing Transactions | $800.00 | | |
| Dividend to Members | 922.00 | | |
| Ladies' Intercollegiate Hockey Cup | 300.00 | | |
| Depreciation | 50.00 | | |
| | | $2,072.00 | |
| Net Profit, April 30th, 1922 | | 206.22 | |
| | | $2,278.22 | |
| | | | $2,278.22 |

H. J. COULTER,
Treasurer.

# ENGINEERING SOCIETY ELECTION RESULTS.

## 1922-23.

### Engineering Society Executive.

| | |
|---|---|
| *President* | F. J. Lyle |
| *First Vice-President* | C. A. Norris |
| *Second Vice-President* | T. M. S. Kingston |
| *Treasurer* | M. E. MacQuarrie |
| *Secretary* | J. W. Kennedy |
| *Curator* | W. R. Boake |

### Chairmen of Clubs.

| | |
|---|---|
| *Civil Club* | W. J. McLelland |
| *Mining and Metallurgical Club* | W. S. Maguire |
| *Electrical and Mechanical Club* | H. E. Wingfield |
| *Chemical Club* | L. M. Price |
| *Architectural Club* | A. S. Crawford |
| *Debating Club* | A. V. Price |

### Athletic Association Executive.

| | |
|---|---|
| *President* | A. A. Bell |
| *Vice-President* | J. G. Cade |
| *Secretary-Treasurer* | K. V. Heyland |

### Year Presidents.

| | |
|---|---|
| *Fourth Year President* | R. G. Morrison |
| *Third Year President* | W. J. W. Reid |
| *Second Year President* | P. L. White |

### Year Athletic Representatives.

| | |
|---|---|
| *Fourth Year* | C. H. Lucas |
| *Third Year* | R. H. Keefler |
| *Second Year* | W. L. Thompson |

### School Y.M.C.A. Executive.

| | |
|---|---|
| *President* | J. C. Dumbrille |
| *Vice-President* | J. Beattie |
| *Secretary-Treasurer* | T. H. Jenkins |

### School Representatives on Hart House Committees.

*House Committee*—C. T. Carson, F. J. Lyle.

*Library Committee*—F. L. Lawton, W. L. Miller, V. N. Bruce, E. Cowan.

*Hall Committee*—A. W. McQueen, R. G. Morrison, F. W. Higgins.

*Billiard Committee*—W. T. Q. Bell, A. W. Carew, P. L. McVicker.

*Music Committee*—C. B. McQueen, N. S. Grant, G. K. Crowe, F. B. Boswell.

### '22 Permanent Executive.

| | |
|---|---|
| *President* | H. G. Thompson |
| *First Vice-President* | W. B. Ramsay |
| *Second Vice-President* | D. L. Pratt |
| *Secretary-Treasurer* | H. S. Weldon |

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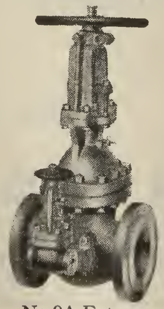

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No. 36 1922-23

# The Transactions
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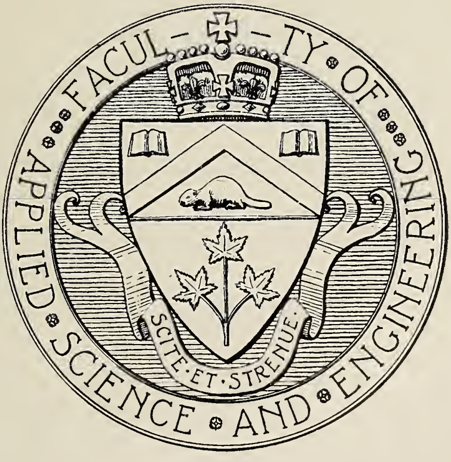
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and to

Dean C. H. Mitchell

Honorary President of that Class

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Dedicated

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# *Foreword*

## ADDRESS OF THE RETIRING PRESIDENT

The publication of this book marks the close of the activities of the Engineering Society for another year. A review of them is unnecessary, for it is my hope that the entire book is exactly that.

On looking back over the year's work and the results of that work, one is struck with the conviction that the Engineering Society has grown to fulfil to a great degree the non-academic requirements of the students of this Faculty. To accomplish that completely will, I hope, be the motive directing the policies of future executives.

Centralization in the Engineering Society of all the activities of "School" men, has now been practically reached. Undoubtedly, this centralization is necessary for sound financial support and a successful business administration. However, this centralization should not be carried to an extreme in which the various organizations are hampered in developing along individual lines. Rather the reverse should be held and the existing organizations should be given a free hand to develop themselves, with constant observation by the Executive of the Society to detect lagging efforts or radical missteps. In this case, the Society should step in and give moral, financial and publicity support towards a rejuvenation of that organization's work. In this way only can the whole system be kept running at maximum efficiency.

The Executive of the Society should keep in view those general policies with respect to the non-academic needs of its members, and function towards their fulfillment.

Firstly, the be-all and end-all of its existence should be to foster and develop that tribal loyalty among its members which has come to be known as "School" spirit. School men have attained a high reputation for the sincerity of that "spirit" here in the University and outside. Not only should this tribal spirit be fostered because its reality alone makes possible the success of the multitudinous activities of the Society, but because it is a splendid thing to develop in young men. A capacity for loyalty and unselfish co-operation is an inestimable quality in the make up of any man, and a great factor towards his success and towards holding the respect of his fellows.

Secondly, the Society should endeavour to provide means for its members to become well acquainted. Undoubtedly one of the most valuable results of University education is the friends and acquaintances made. They not only make pleasant our four years stay here, but prove to be a great boon and pleasure in life after graduation. The Society has all the machinery to accomplish this end and every effort should be made to draw out the hermit and inculcate a spirit of wide and real friendship among its members.

Thirdly, the Society should stand firmly and whole heartedly behind the efforts of the School Athletic Association, for on its activity, to a great degree, depends the status of the "School" in the competitive life of the University.

Fourthly, the Supply Department should be a means of saving money to the students. It should be a convenience and a real assistance by supplying the most requisite and helpful materials for their school work. It should be the community centre around which the life of the school revolves.

Fifthly, the Society should be the means of promoting a good understanding between the faculty and the students, for by a good understanding and complete exchange of views alone, can confidence be retained on both sides and the best obtained from the course. This year the formation of a Liaison Committee, which meets monthly, a committee composed of members of the Faculty in conference with the four year presidents and the president of the Engineering Society, has been a great step in this direction, and it is hoped that it will continue and grow in activity and importance.

Sixthly, the Society should endeavour to add to the regular course of the school as much non-academic education as possible. This can be best accomplished by the clubs themselves obtaining addresses from practical men engaged in their particular branch of engineering, and a few general meetings of the Engineering Society addressed by the best speakers procurable on subjects of general engineering interest.

Lastly, the Society should take its place in University activities and assist to the full extent of its resources, for only by the co-operation of the major faculty organizations can the success of University functions be assured.

In conclusion, the future executives of the Society would be well advised to observe that the program of the Society has changed considerably from year to year, and that its success to a great extent depends on its elasticity, for times are changing and people and students change with them.

I wish to thank the Dean and the Faculty for their support and advice, the executive and all members of the Society for the remarkable way they have supported me this year, and especially thank those few good souls who have been most closely connected with the work and have so generously given their time and best efforts to the work of the Society.

To my successor, Bill Osbourne, a successful year and a merry one.

F. J. Lyle.

THE TRANSACTIONS of the
University of Toronto
Engineering Society

WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 36 TORONTO, APRIL 15, 1923 1922-23

# SOME LARGE ENGINEERING PROBLEMS AND THEIR SOLUTION*

By T. Kennard Thomson, S.P.S. '86.

There is probably no contractor in the country who has not had occasion to express his opinion of some young pile inspector in very strong language. For the old contractor knows that the pile has been driven as it ought to be driven in that location, while the young inspector insists that they are just at some thin crust and insists on the further pounding of the pile, when all of a sudden the pile drops six or eight feet. "There," exclaims the young man, "I told you, we have gone through the thin crust now, so keep on driving until you come to hard bottom." But what really happened is that the pile had simply been pounded to destruction. In the case of some oak piles driven at Columbus, Ohio, described in Engineering News, of January 14th, 1909, the engineer states that 38 per cent. of these oak piles were destroyed in the driving.

Wooden piles, concrete piles, open coffer dams, pneumatic caissons, all have their proper places, and should be used there. And as regards the pile, the engineer should know before he starts driving how far he should drive it, instead of judging by the amount of battering on top.

### Vacuum Method

In 1852 an ingenious gentleman by the name of Potts attempted to put some six-foot diameter cylinders down 25 feet or so by the vacuum method, for he figured that if he pumped all the air out of the cylinders the weight of the atmosphere would amount to some 30 tons, and would be sufficient to drive these cylinders to the required depth. But, unfortunately for the inventor, logs were encountered, so his method would not work. The reverse was then tried, which was called the "Plenum Pneumatic" method. It was the first attempt to use compressed air for foundation work in America.

---

*From an address before the Society.

### Caissons

The next case was at the Third Avenue Harlem River Bridge, New York City. In this case a French engineer was engaged at a very high "per diem" which he innocently thought would continue to the end of the job. But, unfortunately, after about one week the contractor, who thought he had learned all the Frenchman could tell him, laid him off. This bridge had all cylindrical caissons, each ten feet in diameter.

The next caisson job was the first big caisson work in America, used for the Eads Bridge, St. Louis, Mo., in 1869. It is a liberal education to read the history of that bridge, so I hope that you have it in your library. As you know, we now have many text books and formulas for designing bridges and caissons and so on, whereas Eads had to make his own formulas, design his own shapes, decide what kind of tension members to use, as eye-bars were practically unknown. So the bridge was really a marvelous achievement. He put his air lock down in the working chamber instead of putting it on top as we do now. He had an enormous amount of timber in his deck, 9 to 14 feet, compared with the 3 feet of the modern caisson. I have built many of these, but now we often leave out all the timber in using reinforced concrete.

### Caissons for Building

The first building ever put on caisson foundation was in New York for the Manhattan Life Building in 1893. Here they built a steel caisson and tried building the brick work directly on top of it, but they soon found that the friction of the earth opened up the mortar joints of the brick work.

The contractor for this job though he had an economical method of procedure by blowing out the New York quicksand with more or less water and allowing it to flow into the sewers. But, unfortunately, the city officials were mean enough to object to having the sewers plugged and compelled him to clear the rest of the material away, a much more expensive method.

A pneumatic caisson in the process of sinking carries a lock on top of the working shaft with a top horizontal door and a lower flap door. The top door being open, the bucket drops into the lock and the two halves of the door close around a cable, then the valve is opened which permits the compressed air to flow into the lock. As soon as the air pressure in the lock is the same as that in the caisson below, the bottom or flap door drops of its own weight, after which it is a simple matter to lower the bucket into the working chamber and to attach a cable to another bucket which can be removed while the other bucket is being filled.

The air pressure must be just sufficient to balance the water pressure. As a cubic foot of water weighs 62 1/2 pounds, the weight at the bottom of the cubic foot is 62 1/2 which, divided by 144, gives .434 pounds per square inch, or a little less than half pound for each vertical foot of depth. That means that if the water is ten feet deep the pressure would be 4.34 pounds per square inch. For one hundred feet deep it means 43.4 pounds per square inch.

### Deepest Caisson

The greatest pressure on record was for the Municipal Building in New York City, where we had a depth of 112 feet and a pressure of about 50 pounds. I have always noticed that the actual pressure in the air chamber was very close to the theoretical head, whether in the heart of the city or right in the river.

In the first caisson in the Municipal Building, the pressure being so much greater than the contractor had previously experienced, the air pipe broke, and although it was only fifteen minutes before the pipe had been mended and the air pressure put on again, it was found that in the fifteen minutes the working chamber had been filled with sand, the sand was 16 feet above the deck, and the water 42 feet up the shaft. By a streak of good luck, the workmen had started up the shaft when this accident occurred, and you may be sure that they climbed up that ladder as fast as they knew how. In spite of which the last man had his feet in the water until he got above the 42 feet from the bottom.

The cheapest method of all, where it can be used, is to have a 5-inch pipe with a flexible hose at the bottom, and an elbow at the top. By opening a valve in the working chamber the sand and gravel can be blown out through this pipe as fast as it can be shoveled up to the pipe. In this case the speed of the work depends more on the speed of adding the coffer dam and the weight above than on the excavation.

I have seen the windows of a tug two hundred feet away smashed by the pebbles blown out through this pipe, and it is necessary to use the hardest kind of material, generally manganese steel, for the elbow. I have seen a cast iron elbow two inches thick worn right through in an hour.

### Build Up of Caissons

If the caissons are not more than 25 or 30 feet high, it is generally advisable to place all the concrete to this height before starting to sink. This makes a quick and economical job, and often prevents material from crowding in around the sides, greatly increasing the friction. In New York City I have carefully estimated the friction, and find it to vary from 30 to 650 pounds per square foot of a superficial exposed area.

### Caisson Disease

No one should be allowed to enter a compressed air chamber without a thorough medical examination, and anyone with a bad cold or anything the matter with his heart or lungs should not attempt to enter. Much more attention is paid to this now than formerly.

The first sensation in the lock is plugging of the ears or nostrils, and if this is not relieved the ear drums or blood vessels in the forehead may be ruptured. As for the drums, one soon learns how to equalize the pressure on both sides of the drums either by swallowing, chewing or holding the nostrils and blowing so as to get the same pressure inside as outside of the drums.

### The Bends

The next trouble is usually called the "bends," named because the first man who experienced that trouble doubled up with pain which seemed very funny to the onlookers but not to the victim.

The bends might be described as sharp twinges like rheumatism or worse, and are generally due to entering the air chamber too quickly, allowing the air to displace the blood. They are also to a lesser extent due to coming out too quickly, from working too hard, or from working too long in the working chamber. In many places the law now specifies the time to be taken in entering and leaving, a law which has greatly reduced the amount of caisson sickness.

It has always seemed to me that foul atmosphere has more to do with this disease than even higher pressure. For when we sunk the caisson in the Harlem River, our men were a good deal troubled with caisson disease when going through the foul river mud, but after passing through the clean clay below at a very much higher pressure, they experienced very little trouble.

I have had the bends twice—quite enough—once in the arms and once in the leg. The first time I obtained relief by electric shocks, which did not do me any good the second time, but I found (that was long before the day of hospital locks) that by going in slowly, not staying in long, and coming out slowly, I was a little better after each trip, so I kept it up until I was free from pain. Nowadays, however, we have well-equipped hospital locks in which the patient can be put and carefully watched while under recompression.

One superintendent in one of the tunnels had a bad case of the bends and was yelling for his doctor to hurry up and put him in the lock, until the doctor lost patience and told him that he would have to wait until he got a dead man out of the lock. This same superintendent once told me that, as he was going into the office, one of his men stopped him and he asked him to wait a minute or two. In a few minutes, however, the man who had just come out of the caisson was found dead. The post mortem did not disclose the cause of the death. So, as the superintendent said, we have a whole lot to learn.

### Caisson Paralysis

But far worse than the bends is paralysis, and after a person has been once paralyzed by compressed air, he has no business to try it again. I have seen many who thought they were immune, but sooner or later their very carelessness resulted in an exceptionally bad attack. When one sees a half-paralyzed watchman or lock tender on these jobs, it is quite evident what the cause of his trouble was. On rare occasions a man is killed outright in the caissons. Many caisson diseases are now cured by re-compression and de-compression in the hospital locks. These locks are required by law in many States.

### Launching, etc.

There are many ways of getting a caisson in position for sinking. Small caissons may be hauled to the site and lowered in position by derricks. The river caissons are sometimes built on shore and skidded into the water. Occasionally skids are not made strong enough and break down. Carelessness is expensive.

### Pontoons

Another way is to build a caisson on a pontoon, which is nothing more than a flat-bottomed boat having a three-inch plank at the bottom and the sides, arranged with a five or six-foot space all around the caisson to permit the building and caulking.

These pontoons have one or more joints in the bottom and are so arranged that when the caisson has been built, perhaps 14 feet or more high, and is ready for sinking, the connecting bolts of the joints are taken out and sand or gravel for weight is placed in the working chamber near the centre of the pontoon. The water is then allowed to flow in until the caisson is floating, taking most of the weight off the pontoon. Then the two halves of the pontoon often shoot out from under the caisson in a few seconds, with the caisson floating like a boat.

A new superintendent who had watched over the launching without using his eyesight properly, tried to launch his first caisson, but let a small amount of water enter and freeze before putting in enough to sink the caisson and pontoon down together. The result was that it took him three weeks to get his caisson off the pontoon instead of a few minutes.

Sometimes tugs are used to pull the halves apart, sometimes blocks and tackle with struts operating near the centre of the pontoon.

### Building on the Site

Out in the Missouri River the water was too shallow to float a caisson and carried too much sediment to make it possible to keep a channel dredged, so in that case we built a platform from which we hung the caisson up by means of sixteen three-inch rods, and after the caisson was ready for sinking, a gang of Italians turned the nuts at the tops of these rods, letting the caisson down gradually.

This looks like a clumsy method but, as a matter of fact, it turned out to be satisfactory and economical in this case, the time required being from twelve to twenty-four hours per caisson.

As an illustration of the trials and tribulations of a contractor, the case of a caisson in the Missouri River is pertinent. This caisson got badly out of plumb, in spite of the efforts to pile the weight on one side while undermining the cutting edge on the other side. The water rose so high that all efforts had to be abandoned for the time being, and finally when the water lowered a little the sand hogs were again put into the air chamber and succeeded in righting the caisson. Up to this time the contractor did not know whether the caisson was a total loss or not.

### Niagara River Water Power

The possibilities of utilizing the Niagara Falls water power have, of course, been obvious ever since the Falls were first discovered. But until very recently it was thought by most that the power was so unlimited that there would never be any need of developing the full force for commercial purposes.

The Porter family for generations endeavored to utilize part of this power, in the first place by operating mills and discharging water at a slight distance below the top of the bluff as they had no machinery in those days for handling the full head.

About 1850 a foresighted pioneer, Horace H. Day, obtained rights for a hydraulic canal which he actually constructed, but, being in advance of his times, he lost a million dollars in the venture. Then, in 1870, when that shrewd Buffalo banker, Jacob Schoelkopf, bought this canal for $75,000, people laughed at him and intimated that the old man was in his dotage. Many of these scoffers, however, would be only too pleased if they had had the ability and foresight to buy that canal, now worth many millions. It gave Jacob's son and grandson an opportunity of developing the Niagara Falls water power on a large scale, which they still control.

Hon. Peter A. Porter, as Assemblyman and afterwards Congressman, introduced a bill for the first hydro-electric plant in Niagara in 1886. This resulted in the first hydro-electric power being delivered in 1895. Scoffers again declared that there would never be a use for 50,000 horse power whereas, now, single consumers take far greater amounts.

This first development was quickly followed by four others, until the five pioneer companies, who staked their money and courage on this untried venture, had developed some 650,000 horse power at a cost of $65,000,000 or $100 per horse power. Being hard-pressed, as is always the case with pioneers, they made some long-term contracts, and sold much of this power from $9 to $15 per horse power.

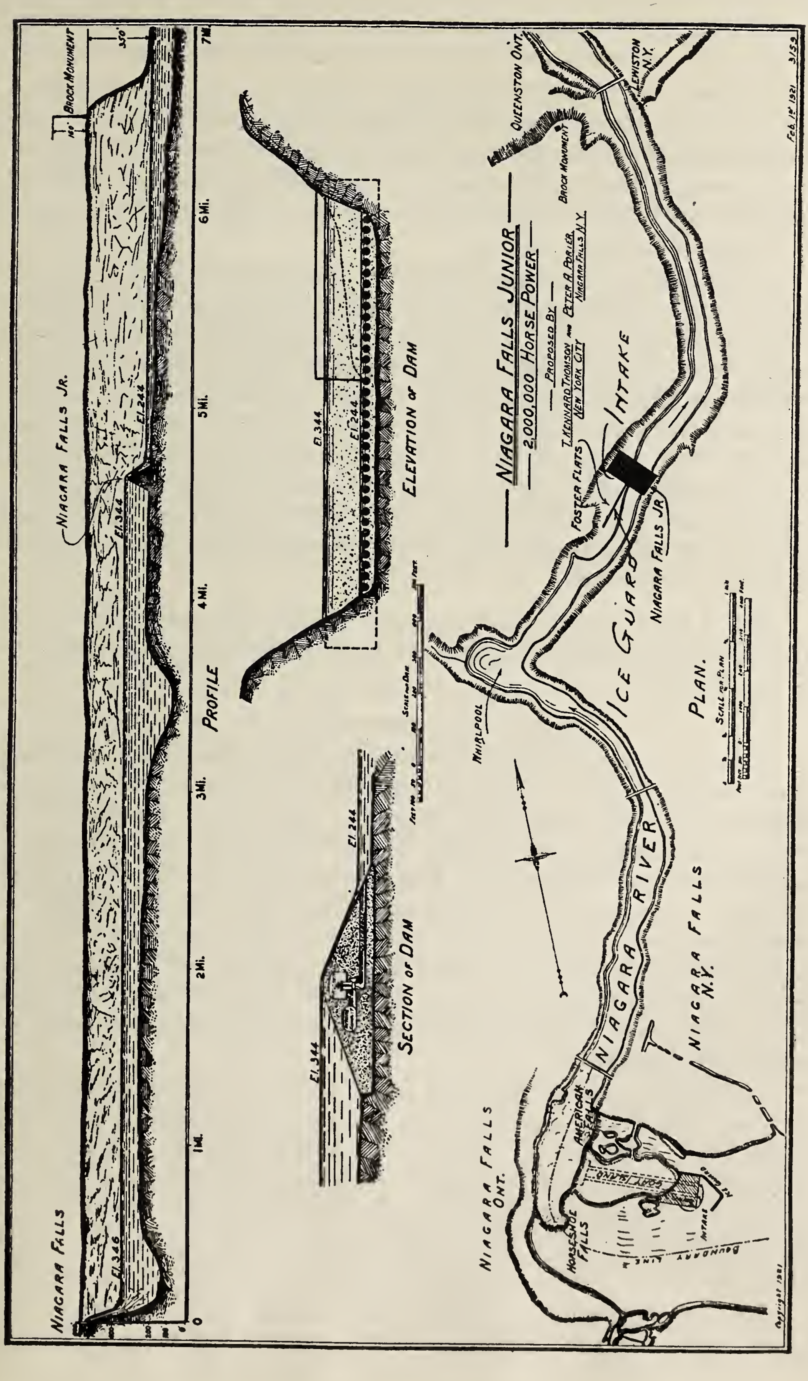
### Effect on Industry

Incidentally, it may be remarked that the development of this water power had far-reaching results, probably never even contemplated by the promoters, and these results undoubtedly affect nearly every household in America without such households having the slightest suspicion of the fact. To take a single example, for instance, this cheap power made many things possible which were impossible before, such as cheap aluminum ware, the cost of which this power very greatly reduced, from $12 a pound to twenty cents a pound. So, surely, everyone who buys aluminum ware must now benefit by this great development, even if they do not know it.

This power also brought into existence, accidentally it is true, carborundum, which at first was sold for something like its actual value, but very quickly reduced in price to about the same extent as aluminum.

In addition to the $65,000,000 spent in the development of 650,000 horse power, the amount of investments in other industries, railroads, electric lights manufacturers and so on, resulting therefrom was $650,000,000, ten times the cost of the plants themselves.

In other words, the indirect value of hydro-electric power is easily ten, if not a hundred, times the direct value. For instance, the development of one hydro-electric horse power is supposed to make permanent work for one man. So if four million horse power were taken out of the Niagara River we would make permanent work for four million men. Utilizing


NIAGARA FALLS JUNIOR
2,000,000 HORSE POWER
PROPOSED BY
T. KENNARD THOMSON AND PETER A. PORIER
NEW YORK CITY
NIAGARA FALLS N.Y.
NIAGARA FALLS
El. 346
NIAGARA FALLS JR.
El. 344
El. 244
BROCK MONUMENT
350'
0
1 MI.
2 MI.
3 MI.
4 MI.
5 MI.
6 MI.
7 MI.
PROFILE
El. 344
El. 244
ELEVATION OF DAM
El. 344
El. 244
SECTION OF DAM
SCALE FOR DAM
QUEENSTON ONT.
LEWISTON N.Y.
BROCK MONUMENT
INTAKE
FOSTER FLATS
NIAGARA FALLS JR.
ICE GUARD
WHIRLPOOL
PLAN.
SCALE FOR PLAN
NIAGARA RIVER
NIAGARA FALLS N.Y.
NIAGARA FALLS ONT.
AMERICAN FALLS
HORSESHOE FALLS
GOAT ISLAND
BOUNDARY LINE
INTAKE
Feb. 1st 1921
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the whole minimum flow of the lower Niagara River and half the flow of the upper river, there would still be left one half the water to go over the Niagara Falls, after the development of four million horse power.

The next step of the development of the river was when the Hydro-Electric Power Commission of the Ontario Government, which had been buying power from the pioneer companies at from $9 to $15 a horse power, decided to obtain more power. It adopted the policy of taking advantage of the fall in the lower river as well as the upper river, and started the Chippawa-Queenston Canal.

The Chippawa-Queenston Canal is twelve and three-quarter miles long and loses about sixteen feet of the head, due to the grade required for a canal of this length and cross section. It was designed for only 16,000 cubic feet per second, whereas the minimum flow of the river is from 200,000 to 220,000 cubic feet per second. In the present international agreement, the Ontario Hydro is not allowed to take enough water from above the Falls to operate its own plants, plus the new plant, so in order to pass 16,000 cubic feet of water per second through the Chippawa-Queenston Canal it will be necessary for Hydro to put one of their old plants out of commission in order to get the extra power, unless a greater diversion is sanctioned.

But if there were no other way of obtaining this extra power, even such expenditure would be justified, as power would still cost a fraction of the cost by coal.

### Cost of Coal-generated Power

It might be mentioned here that when the first power project was being considered for Niagara, coal was being sold at $1.50 a ton, quite some difference from the present price, and when Mr. Stetson, the New York lawyer, was explaining the possibilities in London, they told him that it would never work because power generated by coal only cost one farthing per hour, a farthing, of course, being one-half cent. So Mr. Stetson at once figured out for them that one-half cent an hour amounted to $36 a year, and explained that he would be very glad to sell Niagara Falls power for $15 a horse power. As a matter of fact, he sold afterwards much at $9 to $15. Since that, the increased price of coal enormously increased the difference.

The cheapest power I know of developed by coal before the war was by New York Edison and New York Interborough, the average cost being about $32 a horse power. That means $70 to $80 horse power now. It should be remembered that these are high-grade plants, not average or poor ones. A year and a half ago it was testified in Washington that it has actually cost $100 a horse power at Niagara Falls, N. Y., to develop such power by coal. These prices are of course exceeded in Canada.

No matter what hydro-electric power is sold for, it will always be worth what it costs to develop it by coal, as there will never be enough water power in the United States to do away with the use of coal, until at least we learn how to utilize the tides, either by storage batteries or otherwise.

### Foster Flats Development

Coming back to the Niagara River, we claim that a dam four and one-half miles below the Falls will take care of the entire minimum flow of the lower river, or 220,000 cubic feet per second, and not cost any more than the Ontario government canal, which handles only 16,000 cubic feet per second.

Similar diversions have been sought after on the American side of the line, but obviously they will cost much more per horse power developed than the Canadian efforts, for the reason that the land is much more valuable in New York than in Ontario, and besides there is an enormous net-work of railroad crossings and highways, etc., which are always expensive items. Furthermore, the cost of labor and material has appreciably increased. On the New York side of the line, strenuous efforts are being made to obtain permission to build tunnels, taking the water from below the Falls, and returning it in the lower Niagara River. Advocates for this scheme acknowledge that they can only obtain 75 foot head out of the total 100, which means a permanent loss of that proportion of power.

Then these advocates do not dare ask that the diversion for both sides of the river should be allowed for more than one-half the flow of the river. So, obviously, if they have 75 per cent. head, and half the flow, they would only get thirty-seven one-half per cent. of the value of the lower river, for both sides of the river combined.

This also would be justifiable were there no way of obtaining the full value, but there certainly is. The real solution is to build a dam four and one-half miles below Niagara Falls, on the lower end of what is known as Foster Flats, a really ideal location for a dam and power plants. The location of such a dam is shown in Fig. 1.

This whole project, dam, power plants, transmission lines, interest on the money, etc., would cost less than one hundred million dollars, for two million horse power, as against three to five million dollars for 750,000 horse power, the maximum amount that can be obtained from all minor diversions. As there is a 102 foot drop in the Niagara River, and a minimum flow of 220,000 cubic feet per second, two million horse power can be obtained.

Most people are appalled, first of all, at the idea of a dam in the Niagara River, but I have pointed out to them what an easy matter it would be at this site. For while at many places, the Niagara River is from 150 to 190 feet or more in depth, at Foster Flats it is only about 35 feet. Foster Flats is the only place in the Niagara River where there is a gentle incline before the almost vertical bluffs.

It would be possible to build the first part of the dam on Foster Flats on the Canadian side of the river, on what is now dry land, having the base of the dam some twenty or thirty feet below the bed of the river at that point, making it possible to leave openings in the bottom of this part of the dam to divert water from the present channel of the Niagara River. Then it will be a comparatively simple matter to build the second or last section of the dam in what is now the channel, 500 feet wide, of the Niagara River. The length of the dam will be about 1,500 feet. At present the water level on the site of the dam is some 25 feet above the Lewiston level, so it will, of course, be necessary to blast out some of the rocks below the dam in order to obtain the full hundred foot head.

Many people, even some of my opponents, have acknowledged that sooner or later this dam will have to be built, and as it will naturally be able to handle the entire flow, therefore any and all minor or partial diversions will simply be unnecessary after the completion of this dam. Why, therefore, saddle the ultimate consumer with a cost three to five times as high as necessary?

### Goat Island Scheme

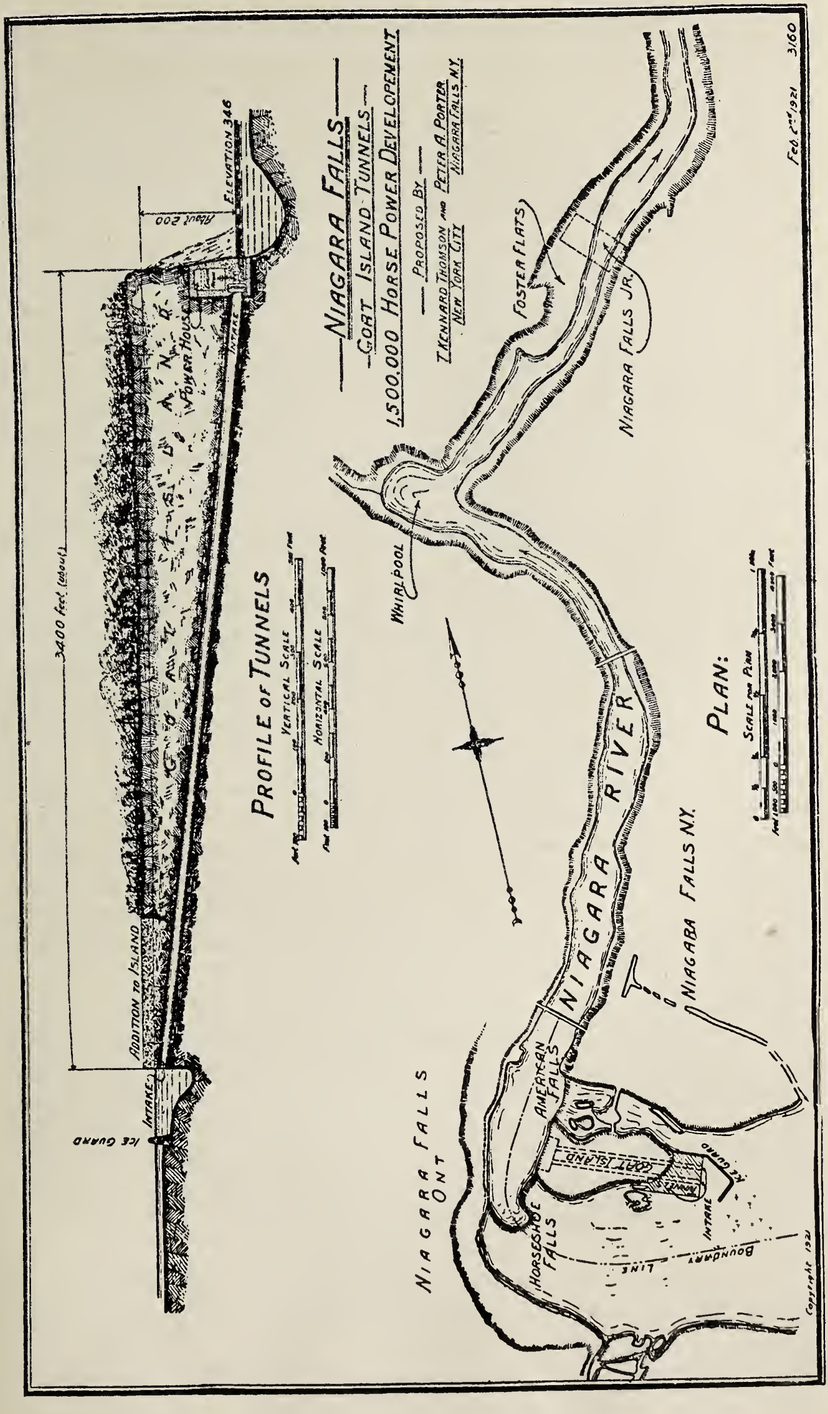
I might state here that while the dam will be absolutely the most economical method of developing the maximum amount of power at the minimum of cost, from the lower river, the method which will develop the maximum amount of power at the minimum of cost for any further diversions of water to be diverted from the Niagara River above the Falls, is our project for tunnels under Goat Island, shown in Fig. 2. By extending Goat Island we would increase its natural beauty for some thousand feet or more, and utilize the 60 foot drop immediately above the crest of the Falls.

It has been recommended that half the flow of the Niagara River be diverted from above the Falls, which if carried through our Goat Island tunnels, would give two million horse power, which added to our two million from the Lower Gorge, would make four million in all.

Many claim that half the flow of the river can be diverted without injuring the view of the Falls. It seems to us that the volume of water has a great deal to do with the marvellous beauty and that any diversion at all must have more or less effect on one of the grandest spectacles in the world. So we claim that our Niagara Falls Junior should be constructed, first, as it does not draw any water away from the Falls, nor the old power plants, and that after our two million horse power is used, and the public is clamoring for more power, then any further diversion from above the Falls which may be decided on should be carried through the shortest possible tunnels, as shown in our Goat Island project.

Surely is it not obvious that 3,500-foot inclined tunnels and a 1,500-foot dam are more economical than tunnels six to ten miles long, or canals twelve three-quarter miles long?

While we have shown the decidedly uneconomical projects which have been completed, or proposed, there is another vitally important point. We know that hydro-electric development attracts manufacturers and industries only on the assurance of cheap power and uninterrupted service,


NIAGARA FALLS
GOAT ISLAND TUNNELS
1,500,000 HORSE POWER DEVELOPEMENT
PROPOSED BY
T. KENNARD THOMSON AND PETER A. PORTER
NEW YORK CITY
NIAGARA FALLS N.Y.
Feb. 2nd 1921
3160
ELEVATION 346
About 200
3400 feet (about)
POWER HOUSE
INTAKE
GOAT ISLAND
ADDITION TO ISLAND
INTAKE
ICE GUARD
PROFILE OF TUNNELS
VERTICAL SCALE
HORIZONTAL SCALE
FOSTER FLATS
NIAGARA FALLS JR.
WHIRLPOOL
NIAGARA RIVER
NIAGARA FALLS N.Y.
PLAN:
SCALE FOR PLAN
NIAGABA FALLS N.Y.
NIAGARA FALLS ONT
AMERICAN FALLS
HORSESHOE FALLS
GOAT ISLAND
INTAKE
ICE GUARD
BOUNDARY LINE
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and that anything that would seriously interfere with these advantages would have very serious results. To take the extreme for instance, if large manufacturing concerns which are working full blast, entirely operated by hydro-electric power, should, without a moment's notice have the entire power cut off, with no chance of having the damage repaired for a couple of years, the disaster would of course be appalling, and naturally the greater amount of power so lost, the greater the calamity.

### Ice Jam Hazardous

Yet once more I claim that it might be justifiable to take such a risk, if there were no way of avoiding it. But there is. It should not need a great imagination to realize that if half the flow of the river were diverted from the rapids, where rocks are now near the surface almost all the way across the river, many of these rocks must necessarily be 15 to 20 feet above the water, and anybody who once witnessed the enormous volume of ice that goes down the Niagara River in the spring, must realize the great danger of a quickly forming ice jam, which might pile up a hundred or more feet in height. Even with such self-evident conditions as the above, an engineer must, if possible, be able to give proofs of such drastic assertions.

We know that some dozen years ago, when no water was being diverted from the rapids, an ice jam occurred, which lasted only eight hours, piling the ice 40 feet above the tracks of the Gorge Railroad, backing the water up to the base of the old Falls, and more or less damage was done to the existing plants, and when the ice jam broke, it absolutely carried everything away from the banks of the river below, to a height of at least 20 or 30 feet above the water's edge, docks, wharves, trees, shrubs, grass. While it has been claimed that the damage was not very great, the only reason that it was not greater was that there was nothing left to damage.

Again, some million of years ago, an ice jam diverted the whole Niagara River at right angles, thereby creating the whirlpool and causing the flow to cut a brand new channel out of bed rock. Undoubtedly there have been many other ice jams not recorded in history.

So, obviously, as a number of times the entire flow of the river has not been enough to carry the ice away, how in the name of reason can half the flow of the river be expected to accomplish the purpose! Therefore it seems that all minor diversions either by tunnel or canal will not only cost three to five times as much, but will be almost sure to result in these diversions, causing financial suicide by destroying every plant in the river. Why go to such unnecessary expense with the danger of destruction so great, when another plan will be safe and economical.

### Foster Flats Dam

The way to handle ice safely is to have deep water and plenty of current, and one of the modern methods of obtaining this is by submerged weirs. Our dam is a submerged weir. By building the first half of the dam high above the water with ice guards confining the ice to a channel directly over the old channel and leaving a fore-bay directly over Foster Flats for an ample intake, we will have a minimum depth of water above our dam of over one hundred feet.

An ordinary dam of this height would have a base of possibly 80 to 90 feet to withstand the pressure, but we want to make our dam 700 feet wide at the base, which will not only give us excessive strength, but will also give us such a flat slope on the up-stream side that no ice can ever be retained, and with such a flat slope on the down-stream side that the ice will have no sudden drop to undermine the foundations, but will have a gradual slide down to deep water.

As we do not anticipate the minimum flow of water when the ice is flowing, there will probably be enough water to carry the ice over our dam, but if at any time this is not so, it will be a very simple matter to shut down one or two of the turbines for the time being, for a few hours, or even if it amounted to a couple of weeks, it would not be very serious.

In this connection, however, we expect to take care of the shortage by auxiliary coal plants. As a matter of fact, the full value of water power will never be obtained without the aid of auxiliary coal plants, for as we all know, uniform power must be supplied to manufacturers and others, and the maximum amount required for peak-load occurs for about half an hour or one hour a day only, so without the aid of auxiliary plants, a large amount of power must be wasted from 20 to 23 hours a day. One of the biggest problems the engineer and business man has to solve is how to use this power continually.

### St. Lawrence River Project

The first step in canalizing the St. Lawrence River should be our project of building a dam in the Lachine Rapids, dredging the channel from this dam down to the City of Montreal, thereby reclaiming ten square miles of land from the river, and creating a million and a half horse power. This proposal is indicated in Fig. 3.

Montreal is now 24 feet above sea-level, without the necessity of any locks below Montreal. Locks in our dam would permit ocean-going vessels to reach Lake St. Louis level about 74 feet above the tide level and three or four such projects would enable boats to reach Lake Ontario, via the Welland Canal, Lake Erie.

The late Sir William Van Horne stated that my Lachine project would make Montreal one of the greatest ports in the world. Eight million horse power could be obtained from the Niagara and St. Lawrence Rivers.

If this work were done under government ownership, God help the countries! But if this is done on strict business principles with proper government regulations, the entire continent will experience a boom, lasting as no boom has ever lasted in the past.

### Manhattan Extension

The addition of six square miles to the City of Manhattan may seem a far cry from Canada, but as a matter of fact the entire continent of North America is like a human system, a small sore on the smallest finger or toe being enough to upset the whole system, whereas anything which benefits the health, wealth and happiness of any part must more or less benefit the entire continent. How much more, therefore, will the construction of a five billion dollar city on six square miles of the most valuable real estate in the world benefit us all?

The reason for this is that everything grown, mined or manufactured in North America as well as many parts of the world, will have to speed up production to supply the demand for this great city.

The only thing that I am afraid of is that when we actually start work with the usual American and Canadian rush and hurry, we will overlook many thousands of details which will make this city surpass in each and every detail, anything which has been attempted before.

There is probably scarcely a man or woman on the continent who could not, if they would, suggest one or more of such improvements, so that everything from the watertight cellar floor to the roof garden, would show the benefit of their help.

In fact the world should be combed for intellects of every branch of industry, not only engineering and architecture, but also in business, education, legislature, administration, banking, manufacture, social service, that is, every calling which goes to make up the work of a great city, should see to it that its particular requirements are properly taken care of, taking advantage of everything that has been done in past centuries and then making further improvements.

### Features of Manhattan Extension

Just to give your own imagination something to start on, we never expect to burn a pound of coal, nor a cubic foot of gas, nor have a horse on the streets.

We never expect to bury a pipe or wire in the ground, but have one street devoted entirely for these utilities, so that all that will be necessary will be to open the cellar door to make the mechanical connection.

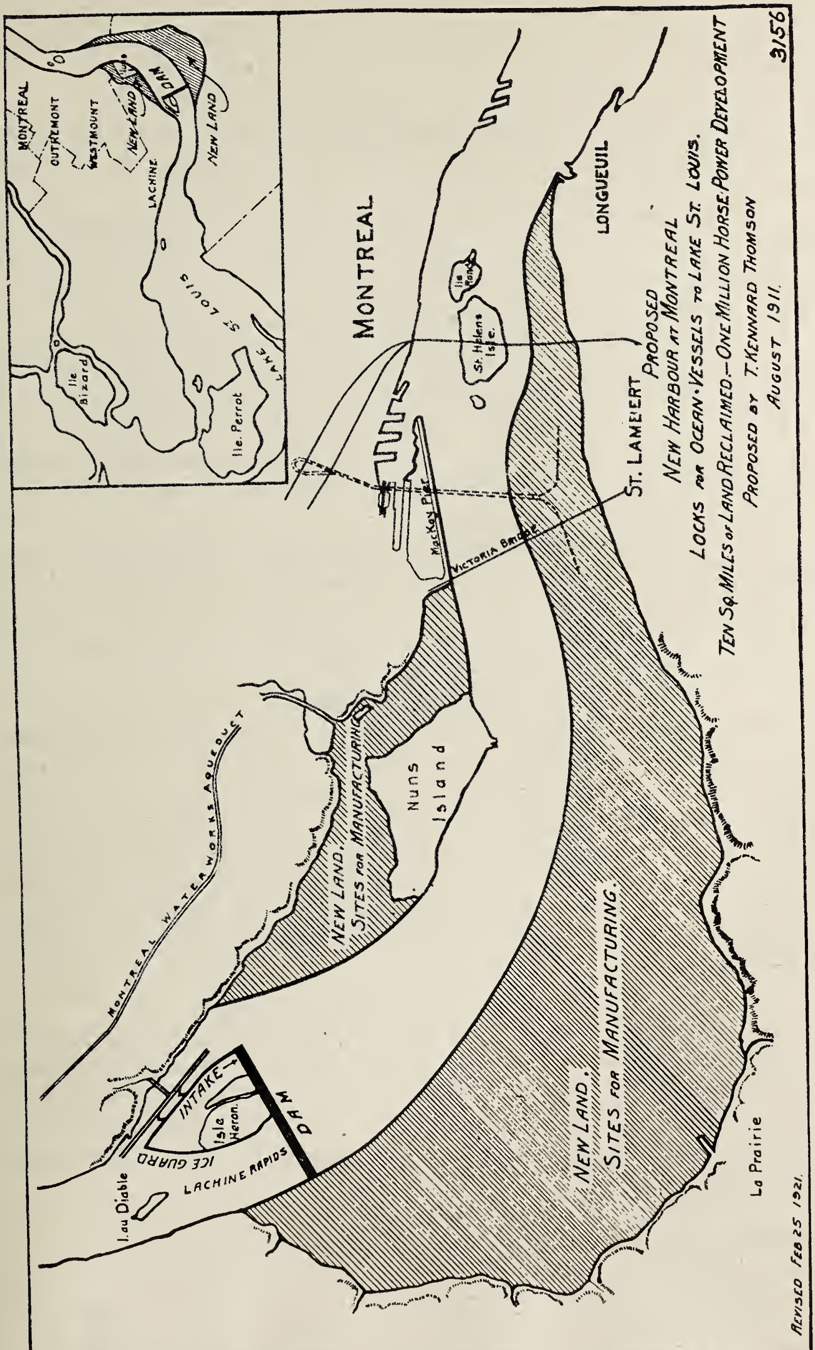
Above this we expect to have three street levels, not dark holes in the ground, but with sidewalks and stores on each side of them, as well lighted, heated and ventilated as the best department stores. The first street level above the pipe level will be for heavy trucking, with railroad tracks around the water front. The next level will be for rapid transit, and the top level will be for light traffic, automobiles, buses and so on.

Every building should cover a whole block and have a roof garden on top of it, with swimming pools where the young children could learn to swim.

The proposed plan calls for six square miles to be reclaimed from New York Bay, and added to the City of Manhattan.

This extension will be done section by section as fast as the land is needed for the buildings. For the first section or two we can probably build outside cofferdams to bed rock, permitting us to pump out the material in between, giving us several square miles of new land without any earth on top of the rock.

Down towards Staten Island where the rock is at greater depth, it may be possible to back fill by pumping sand from the ocean. If we have



PROPOSED
NEW HARBOUR AT MONTREAL
LOCKS FOR OCEAN-VESSELS TO LAKE ST. LOUIS.
TEN SQ. MILES OF LAND RECLAIMED.—ONE MILLION HORSE POWER DEVELOPMENT
PROPOSED BY T. KENNARD THOMSON
AUGUST 1911.

3156

REVISED FEB 25 1921.

to do this, I have plans in my office of one of the greatest dredge experts, of section dredges 40 inches in diameter, such as have been operating in Egypt for years, pumping 50,000 cubic yards of sand a day.

### Fifth Avenue and 42d Street Crossing

One of the most congested crossings in the world is at Fifth Avenue and 42d Street, where the delay, if added up per vehicle or person per year, would be a simply appaling waste of time and money.

At this point 42d Street is ten feet higher at Fifth Avenue than at Madison Avenue and Sixth Avenue, so that if we were to reverse the grade and lower 42d Street fifteen feet at the Fifth Avenue crossing, the grade would be only one half of what it is now.

I have therefore proposed that the level of Fifth Avenue be kept as it is, and 42d Street run under it, turning the present cellars into the ground floors. I have made modifications of this plan to suit the views of the Fifth Avenue Association, which would keep the sidewalks and part of 42d Street the same level as it is now at the present, only lowering the centre so that the automobiles and trolley cars can pass under Fifth Avenue as well as foot passengers.

This means that automobiles and carriages can turn off Fifth Avenue on to 42d Street or vice versa, but can not cross Fifth Avenue on the present grade.

This improvement, in addition to the perpetual saving of time would save many people from missing their trains.

### North River Tunnel

My proposed tunnel for a place like the North River was fully described in the Transactions of the American Society of Civil Engineers, 1920, pages 468-73. In this case I proposed driving rows of piles, building the tunnel like heavy concrete boat, say 170 or 180 feet wide and 500 feet long, which should be sunk on top of the piles after the silt had been pumped out. The joints should be made by sinking pneumatic caissons over the two sections already down, or by attaching pneumatic caissons to each section following the first, so that they simply telescope the preceding section.

### Two Proposed Niagara River Bridges

In conclusion I wish to speak of two bridges which I want to build over the Niagara River, to show what we think of the boys who went "Over There." The three requirements for such structures should be beauty, strength and permanence. It has always seemed to me that the boundary line between Canada and the United States is the proper place for such structures.

The bridge at Niagara Falls should have a clear span of not less than 840 feet, and should be a massive steel structure, encased in concrete, with a hundred-foot roadway above.

The bridge between Fort Erie and Buffalo should have six main spans of 300 feet in the clear, each with a clear height of 90 feet above water, which the marine interests of the lakes have stated would be satisfactory.

# ALLOYS OF IRON AND CARBON

By O. W. Ellis, M.Sc.

As early as 1890 it had been discovered that iron was a polymorphous element and during the past thirty odd years the transformations of this remarkable metal have been the subject of almost ceaseless investigation.

It has been definitely established that on cooling pure iron from 1,530°C (its freezing point) three distinct evolutions of heat ensue—one at 1,400°C., one at 898°C., and one at 768°C. These evolutions of heat are referred to as critical changes in so far as the first two are concerned and as critical range in so far as the last is concerned.

For convenience these transformations are denoted by the symbols Ar4, Ar3 and Ar2 respectively — A = arrest (arrète), r = refroiddisement (cooling), Ar — arrest on cooling.

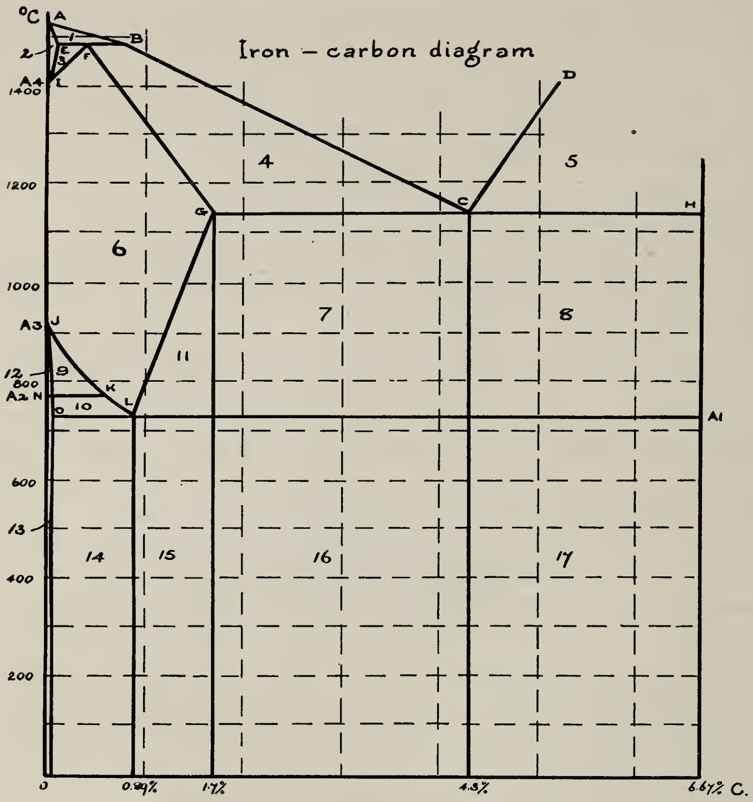
On heating pure iron these transformations occur with absorption of heat at 768°C, at 909°C and at 1,410°C; they are designated Ac2, Ac3 and Ac4 respectively—Ac=arrest on heating (chauffant).

When reference is made to these arrests, but it is not stipulated whether the same occur on heating or on cooling, they are designated A2, A3 or A4, as the case may be. It is convenient to assume that the A2 point occurs at 768°C, the A3 point at 903.5°C and the A4 point at 1,405°C—that is, that under conditions of equilibrium the arrests occur at transformations which are the mean of those at which they occur on heating or on cooling.

Above the A4 point iron is said to exist in the delta state, between the A4 and the A3 points in the gamma state, between the A3 and the A2 points in the beta state and below the A2 point in the alpha state.

To the phenomenon of the existence of an elementary substance in different crystalline state the term allotropy is applied. It having been shown that the alpha, gamma and delta state of iron are characterized by differences in crystalline arrangement, iron is said to exist in at least three allotropic forms. The existence of beta iron as a definite allotrope is disputed, owing to the fact that the change at A2 is associated, not with any crystallographic readjustment, but with a change in the magnetism of the metal. Iron commences to change from the ferro-magnetic to the para-magnetic state at relatively low temperatures. At A2 its rate of change of magnetism is at a maximum. Its magnetism reaches a minimum at 790°C.

Liquid iron is able to retain only a small percentage of carbon in solution. The limits of liquid solubility of carbon in iron have not been accurately determined.



Constitution Diagram

## PHASES PRESENT IN AREAS OF DIAGRAM

| Phase Area | Phases |
|---|---|
| 1. | Liquid plus Solid solution of Carbon in Delta Iron. |
| 2. | Solid solution of Carbon in Delta Iron. |
| 3. | Solid solution of Carbon in Gamma Iron (Austenite) and Delta Iron. |
| 4. | Liquid plus Solid solution of Carbon in Gamma Iron (Austenite). |
| 5. | Liquid plus Cementite. |

6. Solid solution of Carbon in Gamma Iron (Austenite).
7. Solid solution of Carbon in Gamma Iron plus Cementite plus Eutectic (Ledeburite).
8. Cementite plus Eutectic.
9. Solid solution of Carbon in Beta Iron (Beta Ferrite) Delta Iron (Austenite).
10. Solid solutions of Carbon in Alpha Iron (Alpha Ferrite) and Delta Iron.
11. Solid solution of Carbon in Gamma Iron plus Cementite.
12. Solid solution of Carbon in Beta Iron (Beta Ferrite).
13. Solid solution of Carbon in Alpha Iron (Alpha Ferrite).
14. Solid solution of Carbon in Alpha Iron (Alpha Ferrite) plus Pearlite.
15. Pearlite plus Cementite.
16. Pearlite plus Cementite plus Eutectic (Ledeburite).
17. Cementite plus Eutectic (Ledeburite).

Iron and carbon may combine to form a metastable compound, iron carbide, $Fe_3C$, which, under certain conditions, is subject to dissociation

$$Fe_3C = 3Fe + C.$$

This process of dissociation is referred to as graphitization, the carbon resulting from the decomposition of iron carbide being in the form of graphite.

To this carbide the name cementite is generally applied.

Iron and cementite form a metastable system of alloys. The system is metastable on account of the metastability of cementite. The constitution diagram of the system is shown on page 24.

In this diagram the lines AB, BC and CD represent the temperatures at which the alloys of this system commence to freeze. It will be noted that depression of the freezing-point of iron ensues as a result of the addition of carbon to iron. The components of the system—iron and cementite—form an eutectic containing 4.3 per cent. of carbon. The freezing point of the eutectic, to which the name ledeburite is frequently applied, is 1,135°C.

The lines AE, EF, FG, and GH (the eutectic horizontal) indicate temperatures at which these alloys become completely solid.

The addition of carbon to iron elevates the A4 point. This is indicated by the line IE, the slope and position of which make clear the fact that addition of 0.07 per cent. of carbon raises the A4 point to 1,486°C. This percentage of carbon is also the maximum amount of carbon that delta-iron is able to hold in solution.

The solubility of carbon in gamma-iron is indicated by the line GL, the slope and position of which make clear the fact that gamma-iron can retain as much as 1.7 per cent. of carbon in solution at 1135°C, but only as much as 0.89 per cent. in solution at 720°C.

The diagram also shows that the A3 point of iron is reduced as a result of the presence of carbon. The line JKL indicates the manner in which the depression of A3 proceeds with addition of carbon. It will be seen that the addition of 0.89 per cent. of carbon to iron results in the lowering of A3 to 720°C.

Both beta-iron and alpha-iron are practically unable to hold carbon in solution. Alpha-iron, for example, will retain only about 0.03 per cent. of carbon in solution at 20°C. The solubility of carbon in iron at 720°C is little, if any, greater than it is at 20°C.

From the above it will be seen that the 0.89 per cent. alloy is unique in that it is the alloy possessed (i) of the lowest A3 point (720°C) and (ii) of the maximum amount of carbon that gamma-iron is able to dissolve at 720°C. Now, since the gamma-iron of the 0.89 per cent. alloy is subject to transformation into alpha-iron at 720°C and, since carbon is practically insoluble in alpha-iron at 720°C, alpha-iron and carbon, in the form of cementite, are, when this alloy is slowly cooled, precipitated contiguously in the characteristic manner shown in Fig. 7. This structure is referred to as pearlite.

The solid solution of carbon in gamma-iron is referred to as austenite. That of carbon in beta-iron is referred to as beta ferrite, that of carbon in alpha-iron is referred to as alpha ferrite. Pearlite consists of alpha ferrite and cementite.

To recapitulate—at temperatures above 720°C the solid 0.89 per cent. carbon-iron alloy consists of austenite. On cooling the alloy slowly and uniformly, no radical change occurs in its structure until 720°C is reached. At this temperature the gamma-iron changes into alpha-iron and on this account carbon is thrown out of solution in the form of cementite. The products of dissolution, of the austenite—alpha-ferrite and cementite—arrange themselves in the characteristic manner of Fig. 7, a structure to which the name pearlite is applied. The 0.89 per cent. alloy is a eutectoid alloy.

Alloys of iron and carbon which consist entirely of austenite at any stage of their cooling from the liquid state are conveniently referred to as steels. The steels are, then, those alloys of iron and carbon that contain less than 1.7 per cent. of carbon. Commercial steels, however, rarely contain more than 1.4 per cent. of carbon.

Steels containing less than 0.89 per cent. of carbon are referred to as hypo-eutectoid steels, while steels containing upwards of 0.89 per cent. of carbon are referred to as hyper-eutectoid steels.

At temperatures above those represented by the lines JKL and LG the steels consist of austenite. The hypo-eutectoid steels on being cooled slowly and uniformly form temperatures above JKL are subject to structural change when they reach the temperatures represented by the line JKL. Those steels containing less than about 0.58 per cent of carbon undergo transformation at temperatures represented by the line JK. At these temperatures gamma-iron changes into beta-iron and since carbon is practically insoluble in beta-iron the austenite becomes enriched in carbon. As the temperatures of these alloys are depressed, further transformation of gamma-iron to beta-iron ensues, until the temperature 768°C (NK) is reached. At this temperature the precipitated beta-iron changes the alpha-iron. This transformation results in no change in the carbon content of the austenite, which, however, becomes enriched in carbon as a result of further fall in temperature and consequent transformation of gamma-iron to alpha-iron. By the time the temperature of the steel has reached 720°C the enriched austenite contains 0.89 per cent. of carbon—it is of the eutectoid composition—and at this temperature it changes into pearlite. These steels at temperatures below 720°C undergo no further change that need be considered here. They consist of alpha-ferrite and of pearlite in varying proportions.

Those steels containing from about 0.58 to 0.89 per cent. of carbon undergo transformation at temperatures represented by the line KL. The gamma-beta and gamma-alpha transformations being merged in the case of these steels, it may be said that at these temperatures the gamma-iron changes to alpha-iron and as a result the austenite becomes enriched in carbon. Slow and uniform fall of temperature is accompanied by further transformation of iron and further enrichment of the austenite, which by the time 720°C is reached is of the eutectoid composition and changes into pearlite. These steels, being subject to no change below 720°C, also consist of alpha-ferrite and of pearlite in varying proportions.

The 0.03 per cent. carbon steel consists entirely of alpha-ferrite, the 0.89 per cent. carbon steel consists entirely of pearlite. The structural composition of any hypo-eutectoid steel may be determined quite readily given this information. The 0.60 per cent. steel, for example, would consist of

$$\frac{0.89 - 0.60}{0.89 - 0.03} \times 100 = 33.8 \text{ per cent. of alpha-ferrite.}$$

$$\frac{0.60 - 0.03}{0.89 - 0.03} \times 100 = 66.3 \text{ per cent. of pearlite.}$$

The structure of this steel (as cast) is shown in Fig. 3. The proportions of the microconstituents in these steels as cast, differs slightly from those in these steels as slowly cooled. The proportion of pearlite is somewhat greater. This is occasioned by the relatively rapid cooling to which cast steel is subject.

The hyper-eutectoid steels consist of austenite at temperatures above those represented by the line LG, at which temperatures the steels become supersaturated in respect of carbon. On slowly cooling these steels, carbon in the form of cementite separates from the austenite at the temperatures represented by the line LG, and, in consequence, impoverishment of the austenite in carbon ensues. As the steels are cooled further separation of cementite supervenes until, when the steels have attained the temperature 720°C, the austenite is of the eutectoid composition and undergoes transformation into pearlite on account of the gamma-alpha change.

The hyper-eutectoid steels, being subject to no change below 720°C, consist at ordinary temperatures of varying proportions of cementite and pearlite.

The 6.67 per cent. carbon iron alloy (cementite) consists entirely of cementite, the 0.89 per cent. steel consists entirely of pearlite. The structural composition of any hyper-eutectoid steel may be determined quite readily given this information. The 1.15 per cent. steel, for example, would consist of

$$\frac{6.67 - 1.15}{6.67 - 0.89} \times 100 = 95.5 \text{ per cent. of pearlite.}$$

$$\frac{1.15 - 0.89}{6.67 - 0.89} \times 100 = 4.5 \text{ per cent. of cementite.}$$

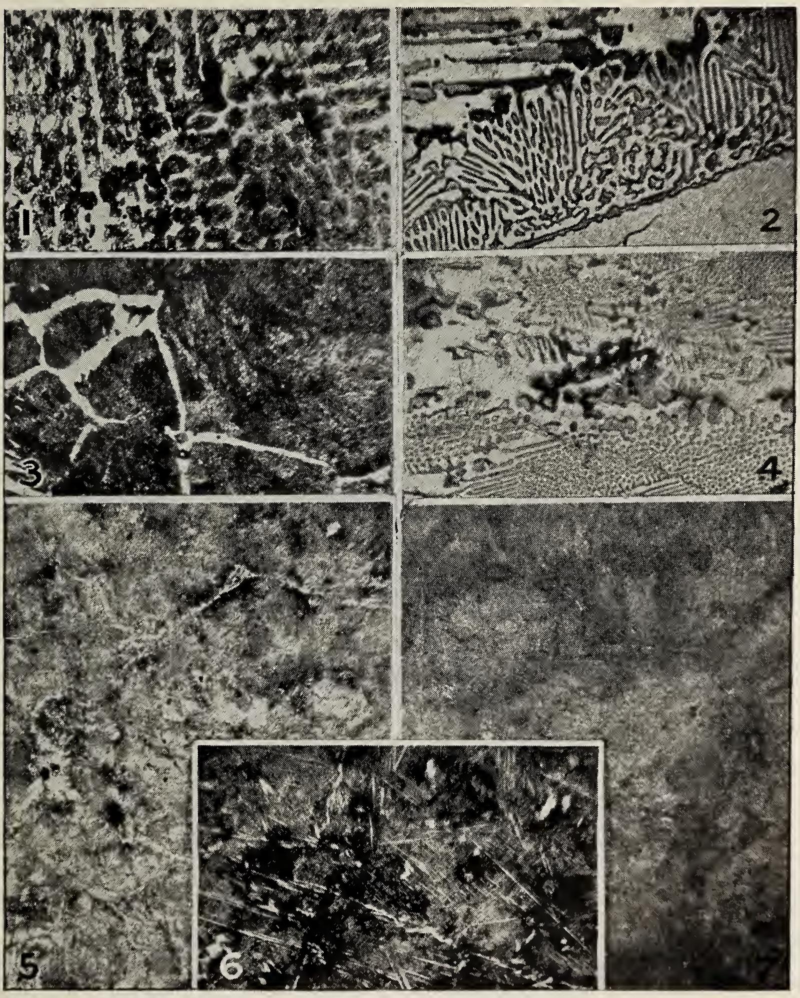
The structure of this steel (as cast) is shown in Fig. 5.

The 1.7 per cent. alloy, it will be noted consists at ordinary temperatures of the products of dissolution of 1.7 per cent. austenite—

$$\frac{6.67 - 1.7}{6.67 - 0.89} \times 100 = 86.5 \text{ per cent. of pearlite and}$$

$$\frac{1.17 - 0.89}{6.67 - 0.89} \times 100 = 13.5 \text{ per cent. of cementite.}$$

This alloy is of special importance in that at 1135°C 1.7 per cent. austenite is a constituent of *all* the alloys of carbon and iron containing more than 1.7 per cent. of carbon. The structure of this alloy is shown in Fig. 6.



*Magnification* 100.

Photo-micrographs of Various Steels.

At all temperatures above 1135°C the 4.3 per cent carbon-iron alloy is liquid. At 1135°C iron becomes supersaturated with respect to carbon and from the liquid carbon in the form of cementite is precipitated. The liquid on this account is momentarily enriched in iron. Now, since all the alloys of carbon and iron containing less than 4.3 per cent. of carbon freeze at temperatures above 1135°C and since gamma-iron is able to retain as much as 1.7 per cent. iron in solution (solid) at 1135°C, precipitation of austenite ensues. The alloy on this account is momentarily enriched (supersaturated) in carbon. Hence, further precipitation of cementite ensues. This is followed by further deposition of austenite, and so on. This alternate precipitation of the constituents, austenite and cementite at 1135°C, results in the formation of a solid of characteristic structure. The structure—ledeburite—is shown in Fig. 4. In this photograph the white areas represent cementite, the dark areas the products of dissolution of the 1.7 per cent. austenite, 86.5 per cent. of pearlite and 13.5 per cent. of cementite. It is, however, impossible to distinguish at the magnification of this photograph the constituents that have resulted from the dissolution of the austenite.

The alloys containing less than 4.3 per cent. of carbon other than the steels, are referred to as hypo-eutectic alloys. They may be considered white cast irons. Commercial cast iron, however, rarely contains less than about 2.5 per cent. or more than about 4 per cent. of carbon.

The alloys containing more than 4.3 per cent. of carbon, are referred to as hyper-eutectic alloys.

Freezing of the hypo-eutectic alloys commences at the temperatures represented by the line BC. It is complete at 1135°C, at which temperature 1.7 per cent. austenite and ledeburite are in equilibrium. At 1135°C the 1.7 per cent. alloy consists entirely of austenite and the 4.3 per cent. alloy entirely of ledeburite. The structural composition of any hyper-eutectic alloy may be determined quite readily from this information. The 3.0 per cent. white cast iron, for example, would consist of

$$\frac{4.3 - 3.0}{4.3 - 1.7} \times 100 = 50 \text{ per cent. of the products of dissolution}$$

of 1.7 per cent. austenite.

$$\frac{3.0 - 1.7}{4.3 - 1.7} \times 100 = 50 \text{ per cent. of ledeburite.}$$

The structure of this alloy is shown in Fig. 1. While not true in the strictest sense it may be said that the white areas represent the ledeburite and the dark areas the products of dissolution of 1.7 per cent. austenite, to wit 86.5 per cent. of pearlite and 13.5 per cent. of cementite.

The hyper-eutectic alloys become supersaturated in respect of carbon at temperatures represented by the line CD. At these temperatures cementite is precipitated. The carbide continues to separate out of the liquid solution until when the alloy is at a temperature of 1135°C the liquid has attained to the eutectic composition. At 1135°C freezing of the alloy is completed and since, apart from the change which occurs in the 1.7 per cent. austenite of the ledeburite, no change ensues on further cooling of the alloy, these hyper-eutectic alloys consist at ordinary temperatures of cementite and ledeburite.

Give that the 4.3 per cent. alloy consists entirely of ledeburite and the 6.67 per cent. alloy entirely of cementite it is possible to estimate the structural composition of any hyper-eutectic alloy. For example, the 5 per cent. alloy would consist of

$$\frac{6.67 - 5}{6.67 - 4.3} \times 100 = 70.5 \text{ per cent. of ledeburite.}$$

$$\frac{5 - 4.3}{6.67 - 4.3} \times 100 = 29.5 \text{ per cent. of cementite.}$$

The structure of a hyper-eutectic cast iron is shown in Fig. 2.

# WITH THE ROYAL ENGINEERS IN PALESTINE

By J. Roy Cockburn, M.C., B.A.Sc., M.E.I.C.

A brief summary of the work of the Engineers in the Egyptian Expeditionary Force during the Great War.

The Palestine campaign, although noted chiefly for the brilliant work of the mounted troops, was nevertheless one of the best examples in history of the employment and co-operation of all arms of the service.

It is the object here to outline briefly the work of one particular branch—the Engineers.

After the second unsuccessful attempt of the Turks in 1915 to invade Egypt and cross the Suez Canal, the British force, known as the Egyptian Expeditionary Force, drove him back across the Sinai Desert and then deployed on a broad front extending from the sea coast at Gaza along the edge of the "Promised Land" to the vicinity of Beersheba.

In the autumn of 1917, after the third battle of Gaza, the British drove the enemy back another sixty miles in the space of nine weeks. This advance was made in all kinds of weather, varying from a sand storm on the desert, to a snow storm in the Judean Hills, and eventually in the autumn of 1918 the Egyptian Expeditionary Force succeeded in the total destruction of the VII and VIII Turkish armies and the liberation of Palestine and Syria from Turkish rule. It is evident that such an army would make great demands upon its engineers.

### The Desert Railway and Water Supply

The problem of transportation and water supply along the lines of communication extending from the Suez Canal to the front line was solved by building a standard gauge double-track railway from the base at "Kantara" across the desert and laying a pipe line alongside. This railway was eventually extended to "Haifa," on the Bay of Acre. The track was laid across the desert at the rate of one mile per day and part of the branch running to Beersheba was laid at twice that rate.

The old metre gauge railway running to Jerusalem was torn up and replaced by one of standard gauge which was incorporated in the general system.

During the war the railway was operated by the Royal Engineers, but after the cessation of hostilities it was taken over and operated by the Egyptian State Railway.

Previous to the III Battle of Gaza the main line of the "Kantara Military Railway" as it was called, had been laid as far as Dier el Belah, seven miles from Gaza.

Before the completion of the pipe line the water supply was carried forward in trains of tank cars. These trains were filled at special sidings

British Captured by the Turks Arriving at Jerusalem and on arriving at railhead were emptied into canvas reservoirs placed beside the track. Here small metal tanks were filled and carried forward on camels to the troops beyond railhead.

When one section of the pipe line was completed a new water siding was provided and the railway relieved of carrying water along that section and so on until water was finally pumped to railhead.

The following is a brief description of the water system when completed:

Water is brought from the Nile near Cairo in the Port Said Branch of the Sweet Water Canal. At Kantara this canal is very close to the west bank of the Suez Canal. Here the Royal Engineers built a thoroughly up-to-date filtration plant having sufficient concrete coagulating basins and mechanical sand filters to treat 600,000 gallons of Nile water per day, and render it apparently perfectly clear to a depth of one metre. As this water is very muddy frequent backwashing of the filters is necessary. The water is pumped from the filtration plant through inverted syphons to masonry reservoirs situated on the east side of the Suez Canal. Centrifugal pumps driven by semi-Diesel oil engines are used for this purpose. The water is chlorinated and then pumped across the desert through a steel pipe line nearly one hundred and fifty miles in length.

This pipe line is lap welded, has screwed joints and is divided into sections each about twenty-four miles in length. The first section of the pipe is twelve inches in diameter, the next ten inches in diameter, and so on, the last section consisting of twin four-inch pipes. Reservoirs and duplicate sets of pumping engines are placed at the ends of each section. At certain points along the desert section of the railway water can be obtained but it is saline and quite unfit for use in locomotives, although used for drinking.

### The Water Supply of Jerusalem

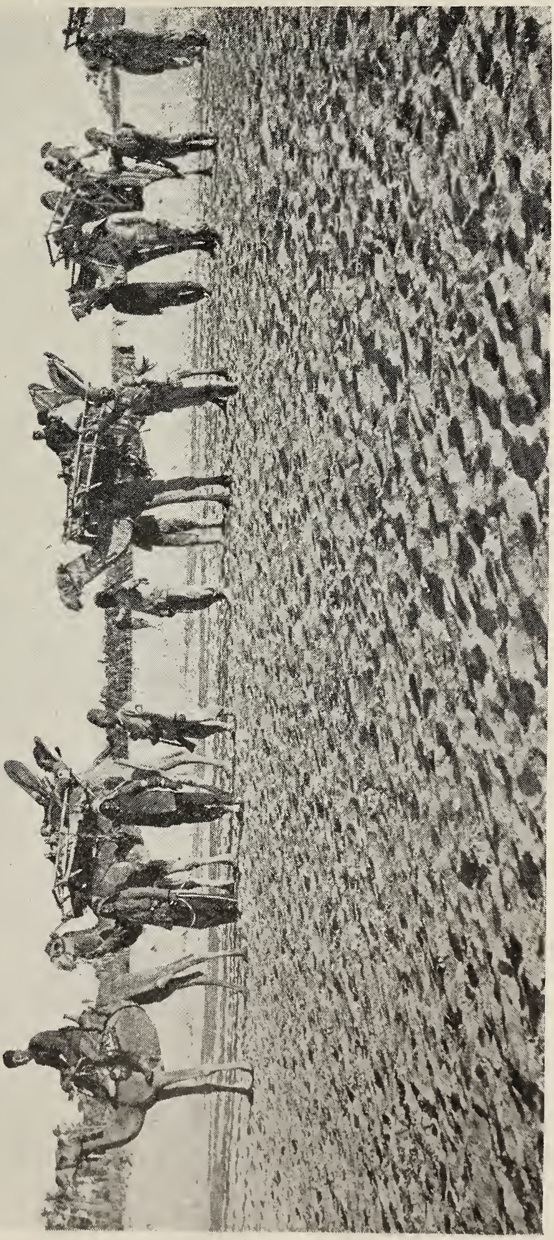
After the army had advanced into the Judean Hills many problems of water supply were successfully solved, one of the most important and most interesting being that of the water supply of Jerusalem.

When the writer first had the privilege of entering the ancient capital of Palestine early in 1918 the water supply came from three main sources.

1. Rain water stored in the cisterns of Jerusalem, a quantity of about 360,000,000 gallons.
2. About 40,000 gallons per day from Solomon's Pools.
3. The Pool of Siloam, which was little better than liquid sewage.

During the winter months the rainfall in Palestine is very heavy and we had much more water than was needed or convenient, but it was necessary to make provision for the coming rainless summer, not only for the troops but also for the 80,000 civilian population of Jerusalem.

The scheme carried out by the Royal Engineers is a modification of the system installed by the Roman Engineers under Herod and Pontius Pilate about 2,000 years ago.



Transporting Wounded on the Desert.

These ancient engineers had brought water through rock-cut channels from the springs of the Wadi Arrub to a reservoir of 4,000,000 gallons capacity, from which it flowed by gravity to Jerusalem through a masonry acqueduct. The Royal Engineers repaired the ancient reservoir and cleared out the channels. They installed a pumping plant to raise the water to a newly erected reservoir of 300,000 gallons capacity from whence it flows by gravity to another reservoir of 200,000 gallons capacity situated on high ground north-west of Jerusalem. The water flows from this reservoir to all parts of the city. Over twelve miles of steel pipes were laid and the whole undertaking completed in the space of nine weeks.

This installation furnishes a supply of 250,000 gallons of water per day and although laid down primarily for military purposes it will be of permanent value to the city.

### Roads

Besides the standard gauge military railway and many light railways a great deal of work was done by the Royal Engineers on roads of various kinds.

Satisfactory roads for infantry and motor traffic were built on the desert by stretching ordinary chicken netting over the sand and spiking it down with long staples. When such a road became rough, due to the shifting of the sand, the netting could be lifted and the sand underneath smoothed out again.

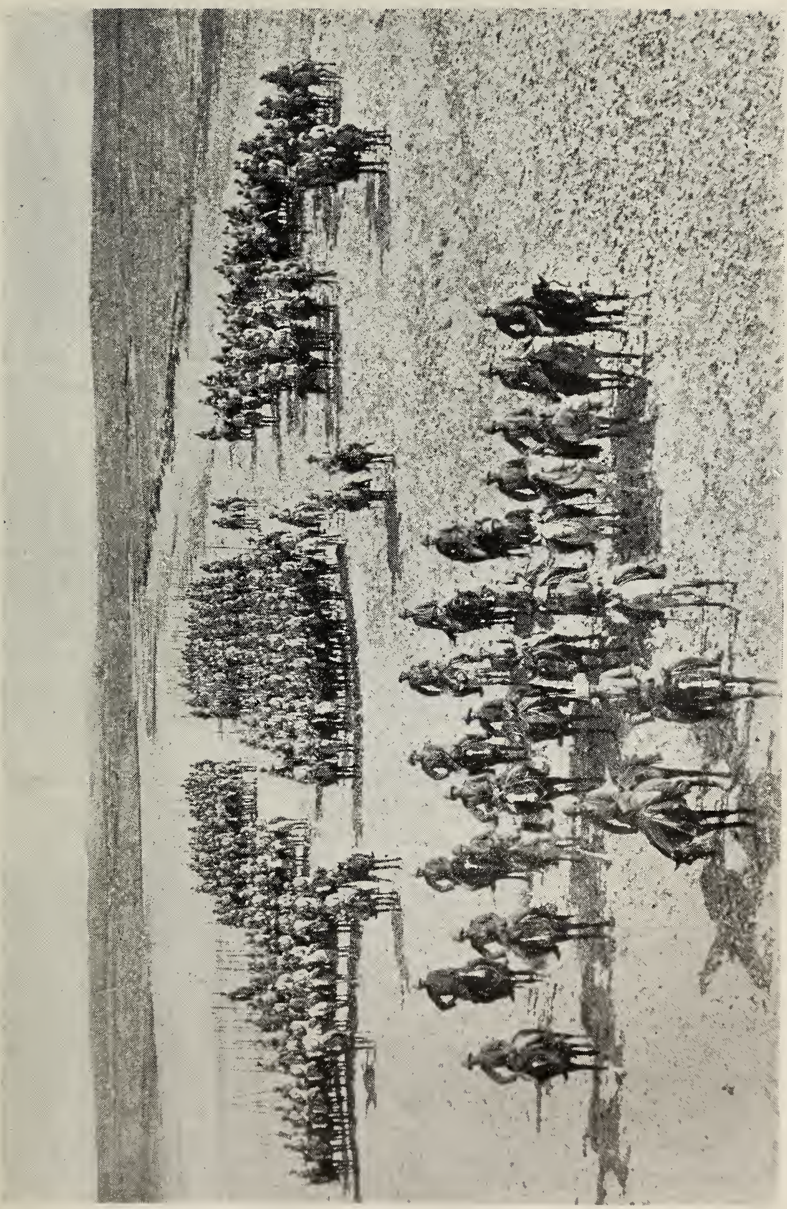
Many permanent roads were built both on the fertile plains and through the hills. In all undertakings the engineers made great use of the Egyptian Labour Corps as well as of the labour which the civilian population of Palestine afforded. It was a common sight to see Palestinians of all ages and of both sexes industriously and cheerfully working at the construction of roads under the supervision of members of the Corps of Royal Engineers, and as far as one could judge all were on the most friendly terms.

### Signal Service

A branch of the Royal Engineers worthy of special mention is the Signal Service. The rapid and wide movements of the troops and the great distances traversed made the problem of intercommunication peculiarly difficult. The sudden change from sandy desert to rough mountain tracks called for great elasticity in transport and ingenuity in building telegraph lines. During the most rapid advance, communication was established between the various units by either repairing old Turkish telegraph lines or running new temporary lines. All such lines were replaced later by more permanent ones wherever the circumstances warranted.

### Field Survey Campaign

During the great war each British army had a field survey company, operating directly under the intelligence department of the army. In France the Field Survey Companies were latterly called Battalions.



Turkish Cavalry near Beersheba

The 7th Field Survey Company, R. E., of the Egyptian Expeditionary Force, like all other survey companies and battalions, looked after such work as field surveys, compilation and reproduction of maps, photography, letter-press printing, meteorological work, and the location of hostile batteries by means of observation and sound ranging.

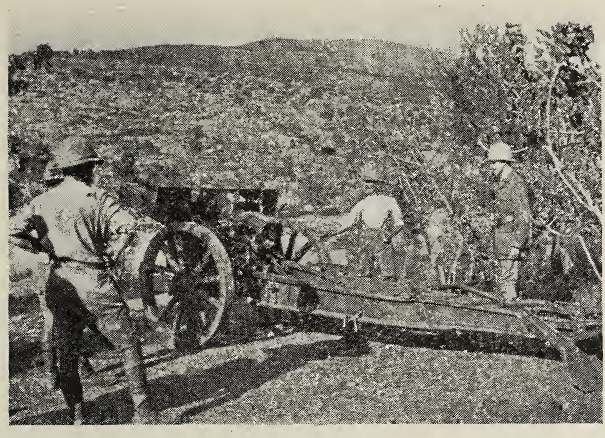
The work of the field parties consisted chiefly of triangulations, plane table surveys, fixing battery positions and datum points for our artillery, and intersecting points in and beyond the enemy's lines. Before the final advance in the autumn of 1918 points had been accurately intersected at distances up to fifteen miles behind the enemy's front line.

Contour maps were printed on the scales—1/40,000, 1/20,000, and 1/10,000. The operation maps on the 1/40,000 scale were printed in four colors. The wadis, roads, railways, villages, wells and such topographical features were printed in black, contours in brown, trees in green and enemy trenches, gun emplacements, barbed wire entanglements and earthworks in red over black. Different classes of roads were also indicated in red.

Contours were surveyed at twenty metres vertical interval in the hilly country, and at ten metres in the plains; spot heights were also taken of the hills. Some sheets were overprinted with a special grid subdivision and enemy battery positions numbered in blue.

The Royal Air Force photographed the whole of the enemy's line and country in the rear to a depth of twenty-five miles, and in addition the main roads and railways leading from the north. Between Jan. 1st, 1918, and the cessation of hostilities, 15,690 photographs were dealt with and the topographical information published in map form. The photographic section of the Royal Air Force showed the greatest willingness to co-operate with and meet the requirements of the Field Survey Company with the result that photographs were used in the compilation of topographical detail maps in the Egyptian Expeditionary Force to perhaps a relatively greater extent than on any other front. Maps showing the disposition of the enemy's forces, to accompany intelligence summaries, were printed periodically. During active operations these maps were printed at night for distribution to units in the field in time for the following day's operations. Such maps were issued for some sixty days. Twenty-six telephoto panoramas were taken from a number of positions commanding good views over the enemy's ground. Two topographical sections were formed in 1918 to compile and print small maps of the enemy's defenses as required. Astronomical observations were made at various places to determine the latitude and longitude.

The meterological section took daily readings of the maximum and minimum temperatures. Humidity, barometric pressure, evaporation, wind and rainfall were recorded four times a day. Daily weather reports were



Captured German 15 c.m. Howitzer in Wadi el Jib near H.Q. "V" Section firing on Turks.

H.Q. "V" Section from across Wadi el Jib.

"A" Post "V" Section Khurbet Abu Felah

issued. Measurements of the upper air currents were made by the observation of the flights of small pilot balloons. During artillery activity balloon flights were observed at intervals of four hours during the day and night.

### Sound Ranging

In August, 1917, two sound-ranging sections, "V" and "N" were sent from France to the Palestine front and in August, 1918, a third section was formed locally in order to use a spare set of sound ranging instruments which had just been sent to Palestine.

Previous to August, 1917, "V" Section, R. E., was part of the 3rd Field Survey Company in France, the headquarters of "N" Section being at Velu, between Bapaume and Cambrai. "N" Section was part of the 2nd Field Survey Company. Scientific sound ranging, as carried on in the various British armies as well as in the armies of our allies, should not be confused with the rough and ready method of observing sound bearings where direction is judged by hearing alone. Our method differed greatly from that employed by the enmy. We obtained records of great precision in which no human element existed, whereas the enemy depended entirely upon the skill of his observers, and a very rigorous discipline designed to make the observer do their best.

We employed an extremely accurate electrical device to give us photographic records, from which intervals of time could be easily read to the nearest 1/100 of a second, and in many cases. to the nearest 1/1,000 of a second, if required. The enemy employed a man with a stop watch for this purpose.

Fig. 1 is a rough plan of the first position of "V" section in Palestine. It shows the positions of the six microphones, of the two advanced or observation posts and of the headquarters of the section.

The distances in metres that the microphones were, east and north of the origin of the survey of Egypt, are given by the numbers on the plan which are placed close to the respective microphone positions. The microphone positions were determined with the greatest possible precision and if a blunder were made in the location of one or more microphones, as frequently happened, it became apparent as soon as the sound ranging instruments were used.

No one was stationed at any microphone position, but at each advanced post there was always an observer on duty with a switch key in his hand. It was the duty of this observer to press the key whenever he heard an enemy gun and keep it pressed until he heard or saw the shell burst.

All information which could be obtained by seeing or hearing was telephoned at once to headquarters, either by the observer holding the switch or by one of his companions. Each microphone and observation post was connected to headquarters by means of two wires. By using the earth as a third conductor between headquarters and the advanced

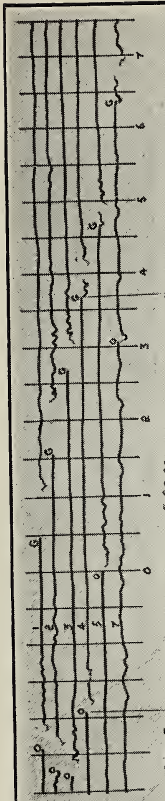


Fig. 5.

Fig. 4.

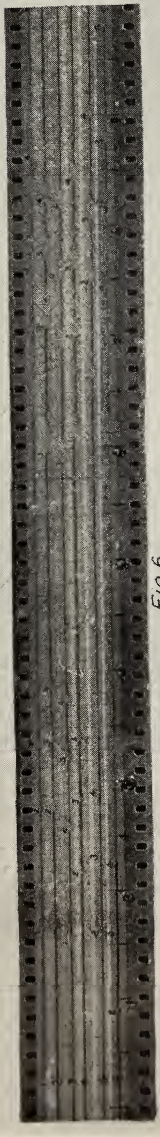


Fig. 6.

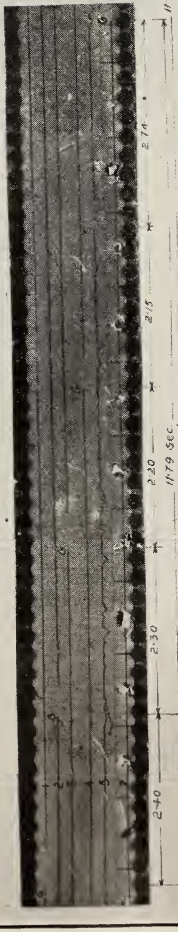


Fig. 7.

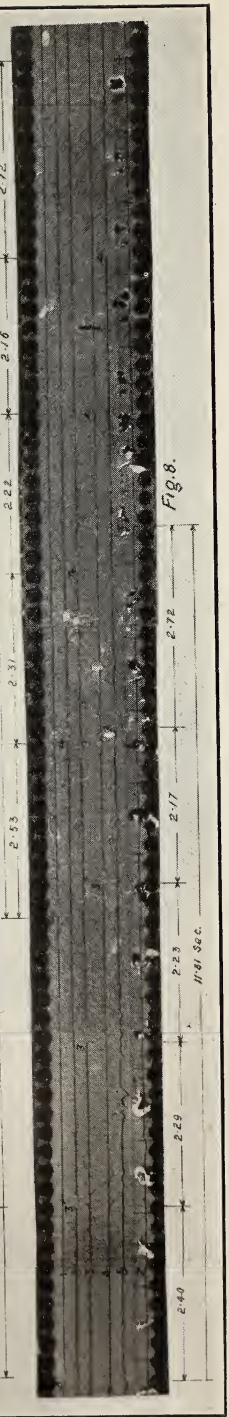


Fig. 8.

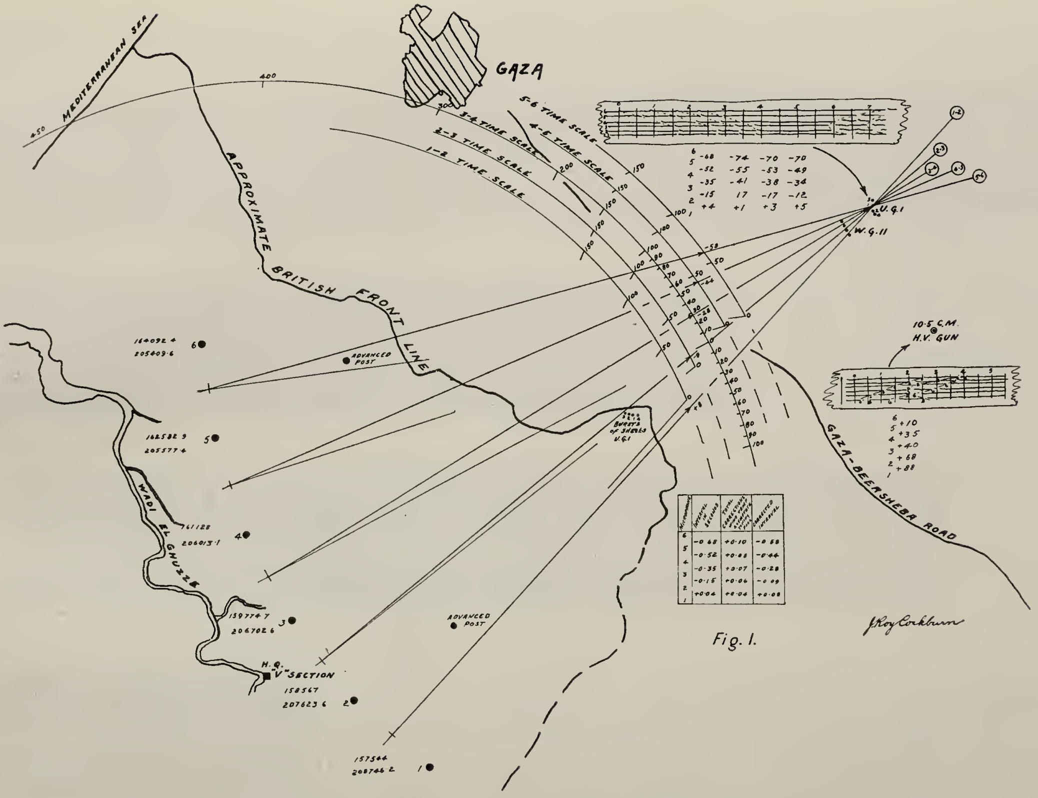


Fig. I.

Diagram Illustrating Computation of Hostile Battery Position from Film Record Reproduced in Fig. 6.

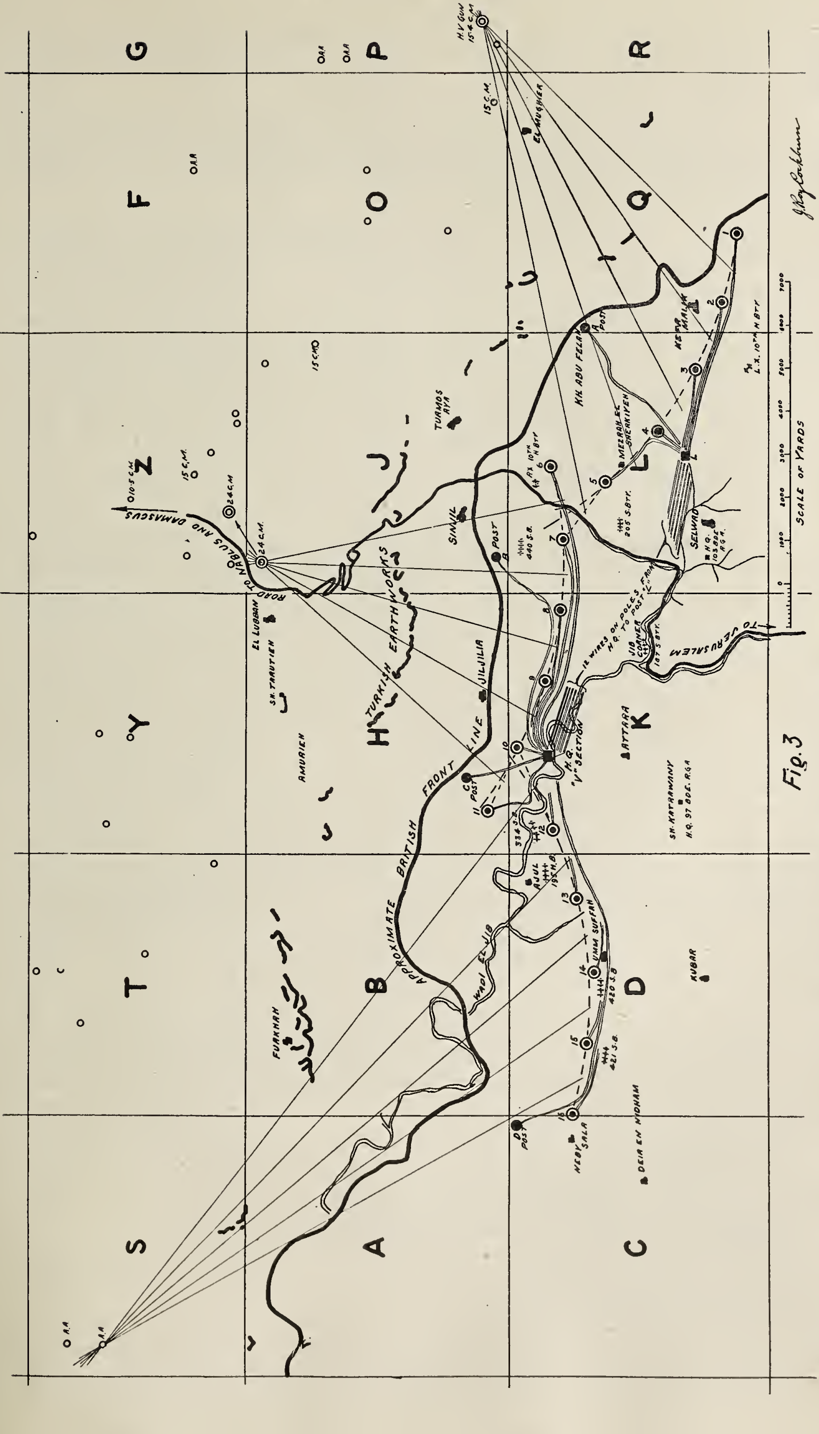


*Fig. 3*

Diagram Showing Positions of H.Q. Microphones and Advanced Posts of "V" Section on the Sinjil Front.

posts, it was possible to operate the telephones with complete metallic circuits, and at the same time use the starting or relay switcnes in the hands of the observer without any mutual interference.

It was important that the telephone circuits should be independent of the earth, because the enemy was always ready to pick up our messages from telephone or telegraph lines.

In Fig. 1, the positions of two 15 centimetre German howitzer batteries, U. G. 1 and W. G. 11 and one 10.5 centimetre German high velocity gun are shown.

Fig. 2 is a reproduction of a film record used in locating the position of U. G. 1. It gives the necesary information to compute the positions of the four guns of the battery, all of which fired within the space of two seconds; also the positions of the bursts of the four shells, and, consequently, a fair idea of the calibre and type of the guns.

This film record indicates that the four guns are 15 centimetre howitzers, 1913 patterns, firing the sixth or largest charge.

Whenever sufficiently large pieces of enemy shells could be picked up, they were accurately measured and the information used to identify the guns. A few days before the III Battle of Gaza, U. G. 1 commenced firing on our front line. It was immediately located and one of our 6-inch howitzer batteries ranged on it. During the shoot W. G. 11 commenced firing with, as we judged, the intention of confusing our sound ranging records. The result was that we obtained a good record of W. G. 11, which proved to be exactly in line with V. G. 1 and our battery, and almost exactly 650 yards closer than V. G. 1. This enabled our battery to carry out a destructive shoot on both the hostile batteries. A few days later, after the Turk had been driven back, it was found on inspecting the ground that all eight gun pits had been heavily shelled and the ammunition scattered around and buried by our shells. The enemy guns had been removed. Fig. 3 is a film record of the 10.5 centimetre, high velocity gun indicated in Fig 1. The points marked "O" refer to the so-called "Onde de Choc" or "Shell Wave." This shell wave always occurs when the muzzle velocity of the shell is greater than the velocity of sound in the air. After the velocity of the shell has decreased to that of sound, this wave travels ahead of the shell and muzzle report, much as the waves from a vessel travel on ahead, when the speed of the vessel is reduced below that of the natural velocity of the waves in water.

The points marked "G" refer to the muzzle report of the gun and are the ones used in computing the gun's position.

The points marked "B" refer to the burst of the shell.

From the relation between "G" and "B," the time of flight of the shell can be computed.

Just before the Third Battle of Gaza, hostile batteries were plotted on the topographical maps from both aeroplane photographs and sound ranging reports; and it was discovered that, in a certain section, the two dis-

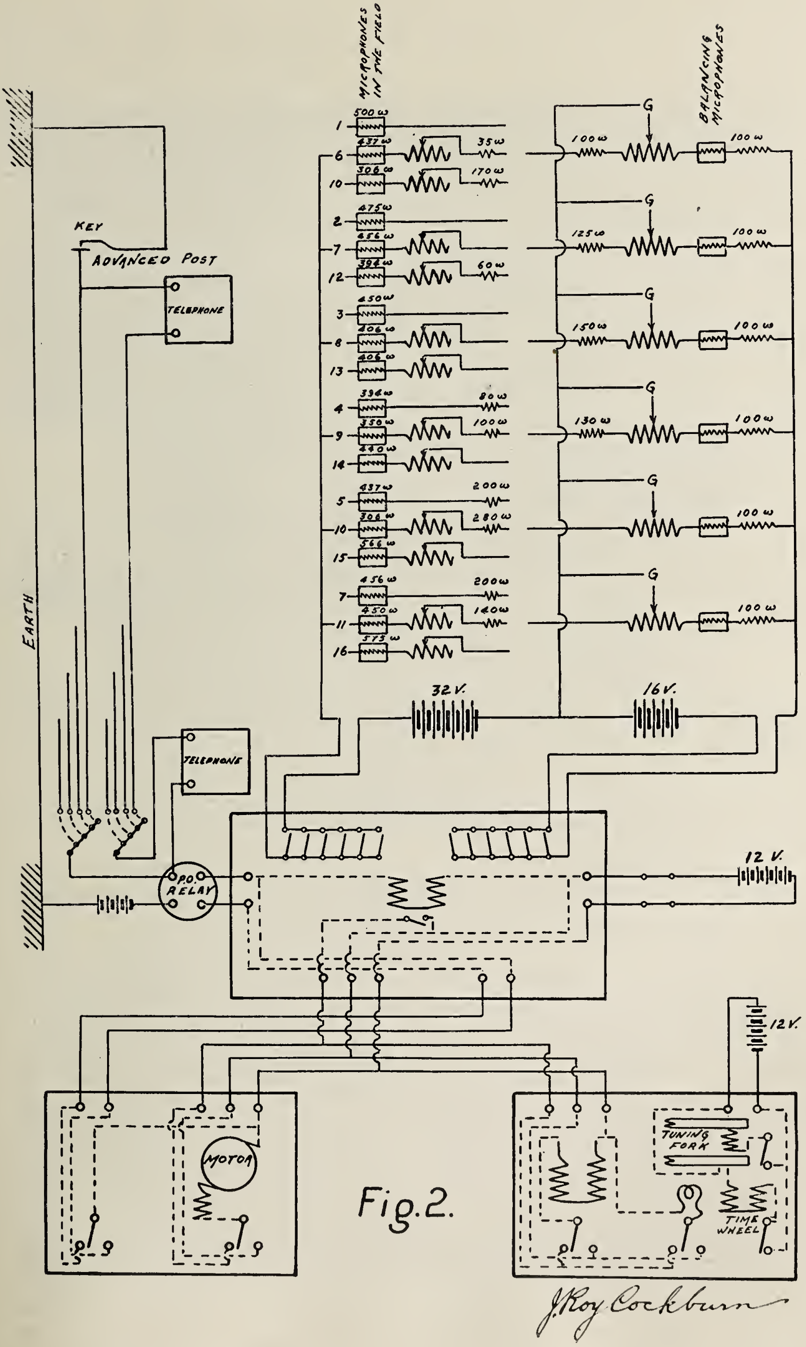


Fig. 2.

Diagram of Electric Circuits, "V" Section, Sinjil Front.

agreed fairly consistently to the extent of about 150 yards. This was taken at G. H. Q. to prove that the sound ranging records were inaccurate, to that extent; but "V" section resolutely maintained that it proved that the topographical detail was wrong. After the Turk was driven back, the ground was accurately surveyed and a new map issued, in which it was found that the discrepancy of 150 yards had almost entirely disappeared.

Fig. 3 illustrates the installation of "V" Section on the Singil Front during the summer of 1918—the only case in which one sound ranging section operated at the same time three sound ranging bases. The three bases were operated from a common headquarters and the efficiency was nearly as great as could have been obtained by operating each base from a separate headquarters. All of the special appliances needed for the three base installations, including nine of the microphones were designed and constructed in the field by the personnel of "V" Section.

As the recording instruments were originally constructed for use with a single base of six microphones, six only could be used at the same instant, but it was possible by moving a single handle to instantly change from any one of the three bases to any one of the others without upsetting the extremely delicate adjustment of the system.

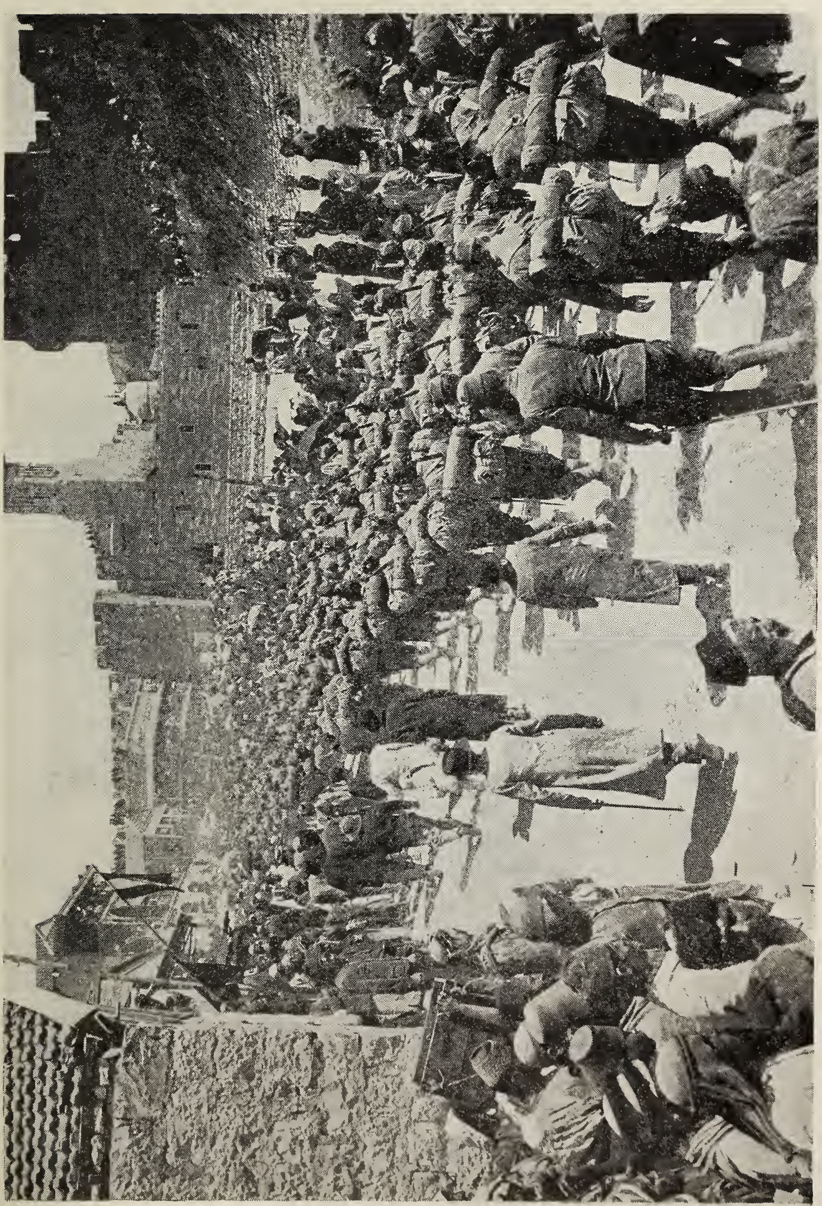
The points which are numbered are microphone positions. It might be noted that No. 7 did duty with both the right hand and centre bases, and No. 10 with both the centre and left hand bases.

The points marked A B C and D, indicate the positions of the forward or observation posts at each of which an observer was always on duty.

Fig. 2 is a diagram of the electric circuits of "V" section corresponding to the position shown in Fig. 3.

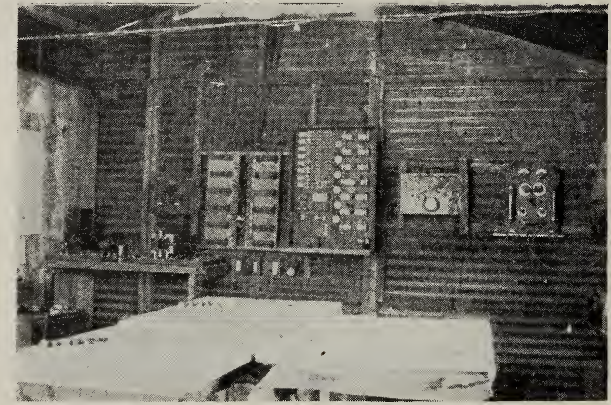
Instead of using the regular Wheatstone bridges for which the instruments were designed, the connections to the galvanometer were made as shown. This allowed two arms of each bridge to be eliminated, thus effecting a considerable saving in current consumption and adding to the sensitivity of the instruments. The balancing microphones shown in the diagram were first tried while on the Gaza-Beersheba Front. Their introduction resulted in the elimination of a very serious fault in the sound-ranging records.

A general idea of the actual operation of a sound ranging section can be given by describing the work of the Left Section of the 10th Heavy Battery and "V" Section in silencing "Jericho Jane," a 15.4 centimetre gun with a range of at least 20,500 yards, the longest range of any gun in Palestine.



Austrian Troops Marching Into Jerusalem. Tower of David in Right Hand Upper Corner and Jaffa Gate near the Centre.

H.Q.
"V" Section
at
Um Jerrar
between
Gaza and
Beersheba.



Recording
Instruments
and
Computing
Boards,
H.Q.
"V" Section.

Officer's Mess
"V" Section
in
Wadi el Jib.

Turkish Camel Corps at Beersheba.

On July 13th, 1918, at 9.20 p.m., this gun commenced firing on Jericho. Immediately the observer on duty at "A" post heard the report of this gun, he pressed his key, thereby closing the relay current. This switched the current on all the microphones of the right hand base. It excited the field of the Einthoven galvanometer which contained six platinum wires, one for each microphone circuit. It started the motor driving the moving picture film in the recording camera, and it turned on the fifty candle-power lamp which furnished the light for the photographic record.

The only part of the instruments kept constantly running was a timing device, driven by a synchronous motor, the speed of which was controlled by a tuning fork, making approximately fifty vibrations per second and interrupting the current supplied to the motor.

From the photographic record of the relative times at which the sound arrived at the six microphones, the time differences were obtained. The temperature of the air and the direction and velocity of the wind were observed and the necessary corrections applied to the time differences. A small correction was also made for the error of the tuning fork.

The velocity of sound in still air of average humidity at a temperature of 50°F is 369.1 yards per second. The time differences were therefore functions of the differences of the distances of the various microphones from the gun. For any one familiar with the properties of hyperbole and their asymptotes, the rest of the process is evident. The location of the gun was worked out graphically on a special computing board covered with a sheet of zinc, which was in turn covered with a sheet of drafting paper glued to it. Under ideal conditions the whole process from the firing of the gun to the finished location could be done in four minutes. On one occasion a computer at "V" section struggled with a very puzzling record, off and on, for twenty-four hours, with the result that he eventually obtained an extremely accurate location of a 15 centimetre howitzer, for which we were ready the next time it fired.

Instantly "Jericho Jane" was located, its position, (P32a0030) was reported to the Counter Battery Staff Officer of the XX Corps, who immediately assigned the left section of the 10th Heavy Battery (LX10HB in the diagram) to retaliate, no other British guns being within range.

The following is a record of the shooting of L X 10H.B.:

First shell from No. 3 gun—300 yards short, 150 yards right.

First shell from No. 4 gun—200 yards short, 50 yards right.

First group of three from No. 3—Range correct, 50 yards right.

First group of three from No. 4—100 yards short, 100 yards right.

It was here noticed that the correction had been applied the wrong way to No. 4 gun, hence the 100 yards right.

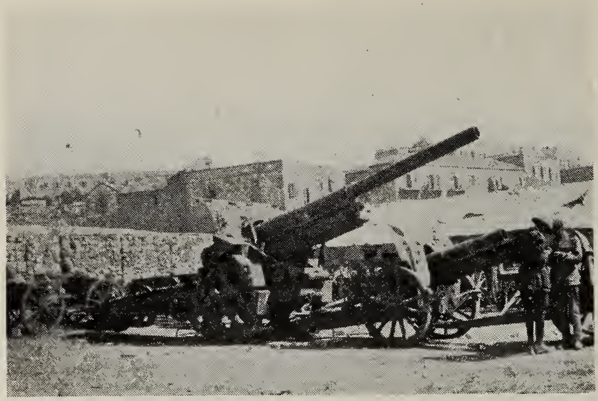
Second group of three from No. 3—50 yards short, line correct.

Second group of three from No. 4—50 yards short, 50 yards left.

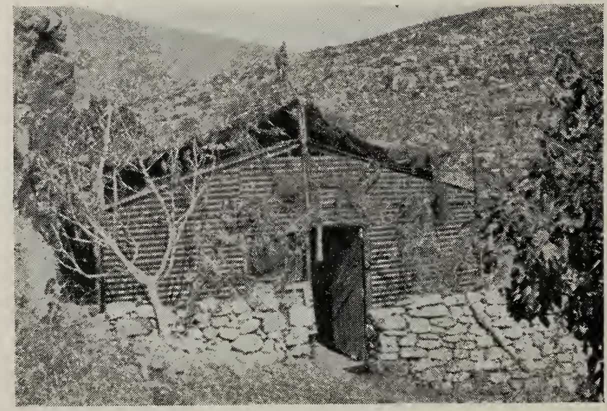
Third group of three from No. 3—70 yards short, line correct.

Third group of three from No. 4—O. K.

Turkish Troops Eating



15 4 c.m. H.V.
Gun
"Jericho
Jane"
in I.O.M.'s
Yard at
Jerusalem.



H.Q.
"V" Section
in
Wadi el Jib.

"D" Post
"V" Section.

Group of eight rounds from No. 3—O. K.

Group of eight rounds from No. 4—40 yards over, 20 yards right.

The left section of the 10th Heavy Battery fired in all sixty rounds; the last groups of three from No. 3 gun were O. K., and from No. 4 gun, range correct, 20 yards right.

During the firing of the groups of eight rounds which were registered by "V" section, "Jericho Jane's" ammunition was set on fire and the gun ceased firing.

"Jericho Jane" was only one of fourteen batteries located by "V" section between 8 a.m., July 13th, and 8 a.m., July 14th, and shoots were conducted on two of the others during that period.

In ranging our own guns on an active hostile battery, it was unnecessary to apply any corrections, because the errors would be the same for the location of the enemy gun and would, therefore, cancel each other; but in obtaining map locations of batteries or ranging our guns on batteries after they had ceased fire, we were very careful in applying corrections. One of the most unsatisfactory things about sound ranging was our inability to correctly observe the constantly changing wind and temperature in the hilly country.

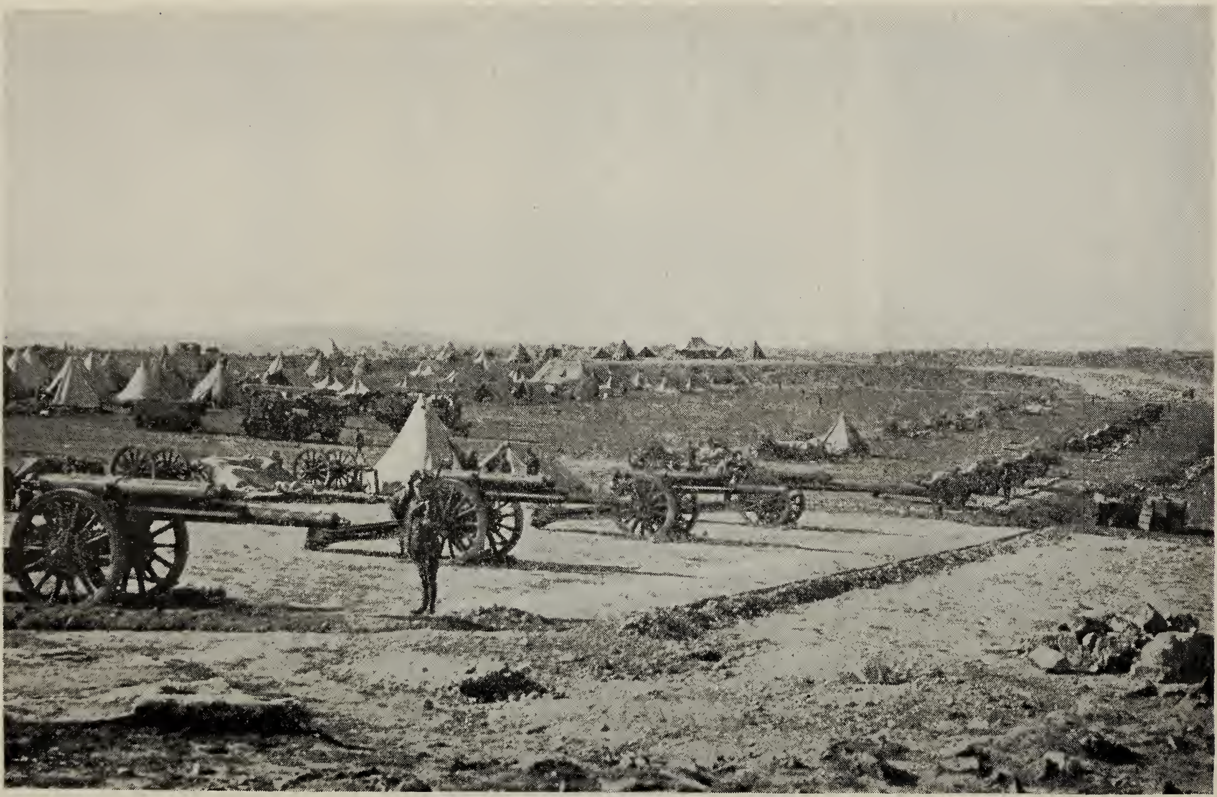
Fig. 7 is a film record of "Jericho Jane" firing at Jericho. As the line of fire was almost at right angles to the line joining the gun position to our nearest microphone, no shell wave was registered on any of the microphones.

Fig. 8 is a film record of the bursts of two shells from the 10th Heavy Battery. It shows No. 3 gun to be O. K. and No. 4 gun 40 yards over and 20 yards right of the target.

During the summer of 1918, 'V" section made a total of 1,106 locations, distributed over 167 hostile battery positions and also conducted 63 sound-ranging shoots involving the location of 1,515 rounds fired from our own guns.

Fig. 5 is a record of "Jericho Jane" firing almost directly over No. 4 microphone. It is clearly shown that the shell wave was 5.60 seconds in advance of the muzzle report. In Fig. 4 the corresponding interval for the 10.5 c.m. H. V. gun is shown to be 1.82 seconds and in Fig. 6 it is shown that no such interval exists in the case of the 15 c.m. howitzers.

Even should space permit, it would scarcely be advisable to give here a detailed description of the apparatus or of the fine points of sound ranging.



British Artillery in the Foreground. Jerusalem in the Background.

Both the enemy and ourselves employed the same mathematical principles, but the success of the British method depended upon the many refinements which were introduced from time to time. The most important and unique device used in sound ranging was invented by Mr. Tucker, an officer of the first British sound-ranging section. This device, although generally adopted, was guarded with great secrecy and the principle upon which it worked known only by those directly interested in sound ranging. The last time the writer saw Mr. Tucker, many months after the adoption of his invention, he was still wearing the single star of a Second Lieutenant in the Royal Engineers.

Each detail of sound ranging was worked out during the Great War and every progressive sound-ranging section was constantly experimenting and improving both the apparatus and method.

When the Turk was driven out of Jerusalem in December, 1917, by the British, he had intended taking the civilian population with him but his exit was so hurried that he even left behind Mr. C. Raad whom he had been employing as official photographer. The photographs of the Turkish troops which are here reproduced are a few of a set obtained from Mr. Raad. The small photographs were taken with a vest pocket kodak and developed at H. Q. "V" Section while in the field.

The ragged appearance of the sound-ranging records which are reproduced is due to the fact that only a few seconds were spent in developing them.

# CONFERENCE ON WATER POWER DEVELOPMENT

By Robert W. Angus, B.A.Sc.

The second conference on water power development was held from Feb. 19th to 27th, 1923, at the University. Like the former one, the one this year was arranged by the writer for the purpose of bringing before the students some of the engineers who are dealing with the practical affairs of life, and who, therefore, come with a freshness that is not possible to bring from inside the walls of the University. In addition to that these gentlemen are able to point out lines of procedure which have met with success, and to give an inspiration and enthusiasm for hydraulic work.

In every case great care was taken in securing the speakers, and all of them were invited as a result of my personal knowledge of their qualifications, so that there was not a speaker who did not bring a message well worth while. The speakers all hold positions of much responsibility and their names are well known in America.

Owing to the objects of the cause, as set before the speakers, the addresses proved of much value to practising engineers, and the interest taken by them was shown by the large number who attended the course.

The subjects for the addresses were selected with the idea of covering the entire field of water power development, although it was not possible to arrange the lectures in logical order, and therefore the course covered financial considerations, preliminary survey, stream gauging, turbines and governors, testing and operation, each being dealt with by a specialist in his own branch.

## Design of Water Power Plants as Affected by Financial Consideration

By J. L. Harper

The first address in the Conference was given by Mr. J. L. Harper, Chief Engineer and Vice-President of the Niagara Falls Power Co., Niagara Falls, N. Y. Mr. Harper is well known to engineers throughout America in connection with this company, and it is largely to his effort that the success of the company is due.

Mr. Harper proved a most interesting and entertaining, as well as a very witty speaker. In discussing the design of water power plants he laid great stress on the importance of building such works with a view to the best interests of the public service rather than that of undue economy, giving instances where extra outlay well repaid the expenditure, on account of the resulting improved efficiency.

The speaker emphasized the value of quiet thinking and said that he had got much of his education on the farm where he could develop his ideas undisturbed. He discussed many of the difficulties which greatly increase the cost of a water power plant, explaining that experience alone teaches the engineer what he has to contend with. Mr. Harper pointed out that while people frequently speak of water as being free of cost for power, the same statement might also be made of coal, as both coal and water are free in a sense in the place where nature has produced them, but just as the cost of coal to the consumers is based largely on that required to take it from the mine and transport it to the place where it is used, so the cost of water used becomes large when one considers the amount of money and thought necessary to bring it to the turbines in an available form.

Some of the obstacles met with were discussed, such as the needs of navigation, danger from ice, and logging operations, and the speaker gave a curious instance in which a cemetery prevented the use of land for water storage and allowed only about half of the water power available to be used.

The lecture closed with a few slides of the new tunnel recently built in Niagara Falls.

### Preliminary Studies and Estimates for Water Power, and Moving Pictures of Some Leading Hydraulic Plants

By H. G. Acres

The speaker on this occasion, Mr. H. G. Acres, graduated from this University in 1903, and, with the exception of about a year, has engaged in hydro electric work ever since. He is chief hydraulic engineer of the Hydro Electric Power Commission and took a very active part in the construction of the Chippawa plant.

Mr. Acres' address had to do with the general preliminaries in connection with the layout of a water power plant, and he discussed quite fully the various factors entering into the selection of a site and the method of studying the effect of these different factors. He selected several different plants, put in by the Commission, as illustrations and showed how the scheme would be tentatively laid out from the general knowledge of the country and the capacity of the various streams.

After the preliminary idea is evolved, careful studies are made with regard to the flow in the stream, the fall available at different points in it, the variation of the flow at different seasons of the year and the possibility of marketing the power; and from these studies the final layout of the plant is made and then the detailed drawings are worked out.

In his second address Mr. Acres showed pictures of some of the Commission's plants, more especially that at Chippawa, and the illustrations proved to be particularly interesting in showing the detailed method of carrying out a job of that magnitude.

### Methods of Measuring Stream Flow and of Estimating the Available Water Supply

By C. C. Covert

This lecture was given by Mr. Covert, who has had an exceptional amount of experience on stream flow measurements, as he had been connected for many years with the United States Government on the Water Supply Section of the Geological Survey, and he was therefore thoroughly conversant with the details of such work. At present Mr. Covert is with the W. & L. E. Gurley Co., for whom he is redesigning parts of their stream measuring apparatus.

The address proved to be of particular interest because Mr. Covert laid stress on serious errors that were likely to creep in in making measurements of stream flow, and pointed out that the actual measurement taken might represent very much more or very much less than the flow in the stream. In this connection he emphasized the need of selecting the measuring station at a point where one had some control of the stream, and said that an artificial control should be put in if a natural control was not available. That is, the gauging station would be put just above the rapids, over which there would be a definite depth of water, this depth being to a large extent a measure of the flow, and, if actual rapids were not available, he said that an artificial dam would be erected.

By this means the effect of back water would be avoided and this is very essential because back water means storage of flow which should be going over the dam.

The desirability of automatic water stage recorders was emphasized, as these keep track of the flow throughout the entire day, and, in certain illustrations, Mr. Covert showed that too few observations often led to serious inaccuracies owing to the varying nature of the flow in some streams.

The method of checking the measurements by plotting velocities, areas and discharges was also explained by Mr. Covert, and his whole address proved to be of particular interest.

### Modern Hydraulic Machinery, Turbines and Governors

By W. R. Keppler

This address was to have been given by Mr. D. J. McCormack, Chief Engineer of the Wellman-Seaver-Morgan Co., Cleveland, and a man who has had to do with the design of many of the largest turbines in use to-day. Unfortunately Mr. McCormack was delayed through illness, and so his place was taken by Mr. Keppler, of the same company, who proved to be an exceedingly good substitute.

Mr. Keppler sketched the advances made in modern turbine design from the earlier stages of about twenty years ago. He showed how the earlier plants had as many as six runners on a single shaft and how the twisting of the gate operating shafts gave such variable loads on the turbines as to cause much difficulty in control. He also discussed the various types of gate mechanisms, and explained the improvement which had been made in these recently, in the way of making the mechanism more reliable through placing the links outside, where they would not be subjected to the deteriorating effects of the water. Toward the end of the lecture Mr. Keppler discussed governing, and the making of the new type governor, showing various improvements which had been made and what these had resulted in in the way of efficiency, and intended to go into a complete discussion of the remote control and the independent governor. Unfortunately the time proved altogether too short and it was a matter of regret that an extra hour was not available for the discussion of governing alone.

### The Testing of Hydraulic Turbines and Measurement of Efficiency

By Professor C. M. Allen

One of the most interesting lectures in the entire course was given by C. M. Allen, Professor of Hydraulic Engineering at Worcester Polytechnic Institute, and a consulting engineer with a very extensive practice, mainly in turbine testing and the development and improvement in their setting.

The methods of testing used by Professor Allen proved to be quite new to most of the audience, as he has not been using the electric generator for producing the load and calculating the turbine output from measurements on the generator, but wherever the turbines have been tested he has removed the generator or pulp grinder or whatever load was there and substituted for it an Alden dynamometer. The development of these dynamometers has been made by Professor Allen in conjunction with George I. Alden and they have brought the apparatus to a very good state of perfection, so much so that they are able to apply them to turbines of quite large powers.

When the turbine is to be tested, Professor Allen selects a dynamometer from his stock and ships it to the place where it is to be used, then attaches it to the machine in place, which often requires a good deal of special setting. Slides explained by the speaker showed him to be a very resourceful man indeed in the way of erecting his apparatus, with very little equipment, and his method of getting the zero loads of the dynamometers with all the equipment in place, were very nicely presented.

The second part of this lecture dealt with the method recently devised by Professor Allen for the measurement of the quantity of water flowing to a turbine, his method consisting of placing in the pipe a penstock, at two different points, a pair of insulated terminals to which 110 volts is applied, and an ammeter in the same circuit shows the current flowing, which will of course be very small owing to the small conductivity of the water. When a measurement is to be made, a quantity of salt is injected into the pipe above the first pair of terminals and the time that it passes under the terminals is indicated by a marked increase in the conductivity of the water, so that by noting the readings of the ammeters at the two points the exact time of flow of this salt solution is easily determined, and from it a very simple calculation gives the mean velocity in the pipe.

The method has met with a great deal of success and the speaker said that his results had given an error much less than one per cent. as compared with volumetric measurements in a tank. It is particularly gratifying that this method was described at this lecture, for the second time only, in public, and we were, therefore, fortunate in having Professor Allen address the meeting.

The last speaker in the course was Mr. Don Carlos, who is head of the operating department of the Hydro Electric Power Commission, and has had to do with the operating of their plants for a number of years, proved very successful in his work. He is a graduate of the University of Missouri. This lecture is printed in detail elsewhere.

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# OPERATION OF WATER POWER PLANTS

Mr. H. C. Don Carlos, Hydro-Electric Power Commission

Address delivered at Water Power Development Conference at the University, Feb. 27, 1923.

Professor Angus has referred to me as a practically trained man. This does not occur to me as being any particular distinction. Any engineer must be a practically trained man. The greater part of all our engineering training and education is obtained outside of what is usually termed our engineering course.

Your degree and diploma is conferred upon you when you have completed the prescribed course in the University, but your real engineering education is obtained outside the University. Most of you, when you have obtained your diplomas, will take them home and put them away in your trunks and forget all about them. I have a diploma some place around the house from the Missouri State University, but I don't even know where it is.

I don't want any of you to misunderstand me as speaking lightly or disparagingly of your University course or the importance of studying hard and doing good work. Your University course is of great importance as a foundation for your engineering training. But don't get the idea that when you have completed your University course, and obtained your degree and diploma, that you are an engineer—you are just ready then to start your real engineering training.

Those of you who expect to follow engineering should get out and learn to do things by doing them yourself.

At this point I should like to draw attention to the value of engineering experience which it is possible to obtain from being directly in touch with the operation and maintenance of mechanical, hydraulic and electrical equipment in service. In my opinion there is no place in the world where a man can get a more valuable experience to fit him for design work, than that of being in direct touch with the performance of equipment in service. Such experience is also of value in educating a man to the importance of layout and is also invaluable to him when he may be called upon to select equipment for any given service. I have noticed that there seems to be an aversion on the part of young graduates to go into this class of work. They seem to prefer the drafting room or office or shop. Shop experience is no doubt of great value but I maintain that a man should have actual operating experience before qualifying as a designing engineer for either equipment or layout.

Don't expect, as soon as you get out of school, to go out and get an engineering position, go out and get a *job.* My first job when I had finished my course in electrical engineering was digging post holes and, having had previous experience at farming, which has to do with the soil, I did fairly well at the job of post hole digging. Then I learned to climb poles, (the linemen called it hiking), and I think probably I was as great a success at this as Mr. Harper was at cleaning horse manure off of street car motors. I think I was considered a first class lineman at one time. At any rate I could handle myself as well on a pole and do as much line work as any of the men I came in contact with. This experience has, I consider, been of considerable value to me.

I learned the blacksmith trade before I went to the University, and during my University course I would go out and work at blacksmithing during the summer vacation. This experience has also been of value to me. Within the last two years we had occasion to do certain repair work on a section of wood stave pipe line at one of the plants. This necessitated a complete shut down of the plant and, of course, we took advantage of the most opportune time which was over a Sunday and holiday, which came consecutively. During the course of the work some special tools were required and as there was no blacksmith available I had to turn in and make the tools myself, which I was able to do on account of my previous experience in this class of work.

The H. E. P. C. at present own and operate 19 hydro-electric and two steam generating stations, which are supplying power through a large number of transforming stations and about 3,200 circuit miles of transmission lines throughout the Province of Ontario.

It is the primary duty of the operating staff to deliver power from these plants and over the transmission and transforming systems, as demanded up to the capacity of the plant, also to maintain the plant in such condition that it will be capable of delivering power when required. This necessitates maintaining a considerable staff with a great diversity of qualifications capable of performing from the simplest operations such as handling an oil can and cleaning machinery to such complicated problems as completely dismantling and rebuilding turbines, generators, governors, transformers, etc., and making studies of water and ice conditions.

In case a piece of equipment of any kind breaks down in service, or fails to properly perform the function for which it was intended, the reason for the failure and the accompanying conditions, must be carefully studied, and in making repairs the weaknesses or defects must be eliminated if possible, and any objectionable conditions removed.

It follows, therefore, that while the design and construction of the plants do not come strictly within the duties of the operating department, there are many features in the design and construction regarding which they should be consulted.

### Simplicity and Accessibility

Two of the most important features in any type of equipment from the operating standpoint are simplicity and accessibility.

These can be sacrificed to some extent where necessary to get the highest efficiency in large main turbines in a plant, but in the case of the auxiliary or service units, on the continuous operation of which the whole of the output of the plant depends, simplicity and accessibility for examination, adjustment and repairs should be one of the principal considerations in the design. The actual output from such machines is only a small percentage of the total output from the plant and a slight loss in the efficiency of these small machines would not be noticed in the total output, while an excessive time to make repairs may interfere with the output from the whole plant. Horizontal units are, in my opinion, more desirable from this standpoint for service units than vertical units.

### Erosion

Erosion is probably caused by air freed from the water when passing through the turbine, due to sudden changes in pressure. This air may contain an excess of ozone or oxygen in a nascent condition, and has a very marked effect on iron and steel, and to a lesser extent on bronze. Pitting, or a sort of honeycombed condition of the surface, is produced and when once started is cumulative, due to the destruction of the smooth surfaces of the vanes. In some cases large cavities have been eaten out of the runner vanes in a very short time.

Owing to the development, in recent years, of electric welding, this is not such a serious matter as formerly. Turbine runners of bronze, steel or cast iron can now be successfully repaired by electric welding. This has practically revolutionized turbine maintenance. We have successfully built up bronze runners, which five or six years ago would have been consigned to the scrap heap. We have built up worn bronze wearing rings and have repaired broken runner vanes in place. The possibilities of this process are so far reaching that they deserve the immediate attention of every power plant management.

### Valves

The valves used to cut off the water from the individual turbines or penstocks require periodic inspection, and, depending on the type of valves used, may, after long periods of operation, require extensive repairs and renewals.

Three main types of valves are used for this purpose, ordinary gate valves, butterfly valves and Johnson valves. Butterfly valves and Johnson valves are more suitable for high pressures and large sizes due to the difficulty of operating large gate valves under high head. While butterfly valves are much cheaper than Johnson valves, they are much more difficult to make watertight. Neither of these types require much attention aside from regular operation at intervals of three or four weeks, to prevent rust and silt accumulations from making them stick. The Johnson valves, however, being hydraulically operated and controlled from penstock pressure, we have found it advisable, where there is a great deal of ice liable to be present in the water, to have a second source of water pressure available for their operation.

The large gate valves at the O. P. plant are operated by electric motors and are quite reliable within their limits until the screws and nuts become badly worn. We found in the case of some of these valves that after eight or ten years operation, the screws and nuts had worn so badly that the valves were likely to become inoperative. They were of the stationary stem type with the screws turning through nuts fastened in the gate, which moves to and fro as the screws are rotated by gearing. The screws and nuts being under water, and inaccessible for lubrication, became covered with rust and dirt which gradually ground away the threads. It would be a comparatively simple matter to repair these if the pipe line above the valves could be unwatered whenever work was to be done, but since this was impossible the problem was one which required some study and much hard work for its solution. Without burdening you with details, I may say that we have successfully replaced the screws and nuts in practically all of these valves without losing the service of a unit at any time when required for load. At the same time, the design of six of these valves was changed to the rising stem type with outside nuts operated by gears, an arrangement which we are confident will avoid trouble with screws and nuts wearing out so rapidly in the future.

### Lubrication

Of course a continuous supply of oil must be provided for all the bearings, and in large size bearings where any considerable amount of heat is generated, it is necesary to dissipate a part of this heat by cooling the oil. This is done either by water cooling coils in the bearing or by pumping the oil through a cooling system or both. In horizontal machines it is often the practice to provide a large oil reservoir under the bearing with cooling coils, then the oil is carried up into the bearings by oil rings. In this case the oil is not circulated outside the bearings. It is self-contained and requires very little attention. Other than this there are two main systems in general use.

(1) Gravity system.—In this system the storage tank is placed at a considerable height, depending on the oil pressure required, and the oil is fed from the storage tank direct to the bearings, then it drains away to a sump tank and is pumped back to the storage tank after being filtered. The gravity system has a great deal in its favour; it provides uniform pressure which is very important in regulating the supply of oil to the different bearings, and the reserve supply is limited only by the size of tank which it is desired to provide. Pumps of almost any type and intermittent in

their action can be used without affecting the supply of oil to the bearings.

(2) Pressure system.—This system is used when pressures are too high for a gravity system or where there is a lack of room, and sometimes for cheapness. It is, however, necessary to have a storage tank in the upper part of which is an air cushion. The oil is discharged into this tank by the pumps before being delivered to the bearings. Without this intermediate pneumatic storage tank, the oil will be delivered spasmodically, depending on the pulsations of the pump, producing vibrations in the whole oiling system, and in addition a large amount of air will be entrained in the oil, which will expand on delivery to the bearing, forming an oil spray which will be carried away by air currents from the rotating machines.

This is especially objectionable in generators as the lubricating oil causes the insulation to deteriorate and dirt collects, clogging up the ventilating ducts, making frequent cleaning both necessary and difficult.

As to the grade of oil to be used in any particular case, it is usually found that the lightest oil that will serve the purpose is the best one, as it will carry away the heat better and the flow is easier to regulate.

Considerable notice has been taken recently of a certain germ treatment for lubricating oils. We have tried this treatment to some extent with rather indifferent success. It is my opinion that there is a wide field for development both in lubricating oils and in methods of lubrication.

### Bearings

The building of vertical shaft turbines and generators in increasingly large sizes has necessitated the development of thrust bearings to carry these heavy rotating parts. The large vertical units built ten or twelve years ago were all equipped with high pressure oil thrust bearings. These necessitated very high pressure oil pumps and a great amount of auxiliary equipment which always gave considerable trouble and was expensive to maintain. In recent years there have been three main types of thrust bearings developed, which are in general use, all of which are giving very good results. The Kingsbury, the Gibbs and the General Electric spring bearing. The principle of operation of all of these is the same, but has been worked out along slightly different lines. These thrust bearings give very little trouble in operation. In fact they probably give less trouble than the guide bearings. The principal trouble with the water lubricated lignum-vitae guide bearings used in turbines is in getting a supply of water for lubrication that is free from sand and grit.

Careful balancing of the rotating parts contributes a great deal to the successful operation of guide bearings.

### Governors

Turbine governors are among the most reliable and at the same time most misunderstood pieces of equipment in a power plant. Governors if of modern and proper design will regulate speed with a high degree of precision, with load variations usually encountered in supplying the average commercial power, and with a reliability that is exceptional. Their main function is, of course, to maintain speed within permissible limits under the varying load conditions, by adjusting the gate opening in the turbines to suit the load requirements. It is impracticable to maintain absolutely constant speed under all conditions, and the governors in any individual plant must be adjusted to suit the conditions encountered in that plant, striking a suitable balance between permissible speed variations and pressure rises in the penstock and wheel cases. The flywheel effect or inertia of the system will, of course, assist the governors in taking care of momentary load fluctuations and tend to maintain constant speed throughout the changes, (in other words the inertia of the system tends to resist any sudden changes in speed).

The governors of the individual machines in any plant or in different plants, if operating in parallel, must be capable of adjustment so that the machines will take their proportional part of the load variations. Or in case it is desired for any reason to have one machine or a group of machines operate on base load, (or constant load) and allow the other machines to take the variations, then the governors must permit of the proper adjustments being made to meet this condition of operation.

The cost of maintaining governors is usually very low if of proper design. The moving parts must be kept clean and well lubricated and when once wear has exceeded a few thousandths of an inch on the valves, they must be repaired, if the governor is to function properly. Deferred maintenance on governors results in unreliability and increased wear and tear on the pumping plant supplying the pressure medium, and in poor speed regulation, and may present a very serious hazard to the plant.

Older types of governors operated on a closed system with a pressure on one side of the pump and a vacuum on the other side. This system required a special oil that would not break down under the vacuum. This special oil is expensive and requires to be renewed at frequent intervals, resulting in high operating costs. Manufacturers of modern governors have abandoned the closed system for the open system, and we are at the present time changing over some of the older governors at the O. P. plant from the closed to the open system.

Both oil and water are used as governor fluid, and if the open system is employed the ordinary lubricating oil generally used for bearing lubrication gives good results. If water is used, it must be treated in some way to prevent corrosion. This is usually accomplished by the use of emulsified oil or potassium-bichromate, or some other treatments which render the water non-corrosive. The governor fluid must, of course, be kept free of solid matter, such as dirt and sand, and it is, therefore, necessary to employ filters if water is used.

One of the principal advantages in using water is that it permits the use of centrifugal or turbine pumps, which have lower maintenance cost and longer life than plunger or gear pumps. Centrifugal pumps are not developed to the point where they are generally used for pumping oil at the high pressures used on governor systems (usually from 150 to 225 lb.). Water is also considerably cheaper than oil.

Both central pumping plants and individual pumps for each governor are employed. In plants having a large number of units, I personally favor the central pumping plant with sufficient spare equipment installed and with automatic features for starting up additional units in case of the failure of one, or the overloading of those in operation.

The central pumping plant tends to cut down the maintenance cost and is more reliable, as there is less liability of losing the pressure in any individual governor which may result in a run-away or poor speed regulation. In the case of a two or three unit plant it is advisable to install individual pumps of sufficient capacity to carry the entire plant and have them all pump into a common pressure header.

### Ice Troubles

In severe winter weather ice in one form or another often presents a very serious problem. We have three different formations of ice to contend with in the Niagara River, hard block ice, frazil or slush ice and anchor ice. The hard block ice forms along the river and lake shore in sheltered spots, and when broken up by shifting winds is carried down the river. This form of ice probably causes more trouble in the operation of plants at Niagara than any other form of ice. In exceedingly cold weather, we often have the block ice and frazil to contend with at the same time; in these cases considerable trouble is experienced. The frazil will collect on the ice diverters and along with the block ice forms a solid mass which tends to clog up the water passages. The only effective way to deal with this trouble is by the use of dynamite. From two to six sticks of dynamite placed in a bag of sand and sunk to the proper depth seem to be quite effective. We have never found that permanent structures were damaged by the proper use of high explosives in this way.

Anchor ice forms usually at night in very cold weather on the bottom of the river, then during the day when the sun comes out, it rises from the bottom carrying with it rocks and other rubbish from the river bottom; being thus weighted, it floats low in the water, goes through under the diverters and finds its way into the turbines where it does more or less damage.

During the winter, conditions in the Niagara River make it necessary for all the older plants to operate with the trash racks removed, (we expect that this will not be necessary at the Queenston Plant). With a slush ice, this is not a serious matter, but when hard block ice and anchor ice carrying stones and rubbish gets into the wheels, all sorts of difficulties are to be expected. Most turbines are provided with breaking links so that in case ice or other material jams in the gates and the governors move the gate mechanism, the gates jammed will be freed by the breaking of the links. These breaking links, however, are not always reliable, and in one case we had a turbine suddenly jam with ice and by a movement of the gates break seventeen out of twenty gate arms besides breaking the links.

In another case two gate links broke, one of the gates turned completely over and wedging with ice and stones acted as a tool would in a large lathe and trimmed off about four or five inches of the runner vanes all round the wheel. The 2½″ solid steel gate shaft was sheared off close to the gate. This turbine was put back into service after replacing the broken gate and cutting off the bent-over vanes, and operated satisfactorily with only a slight decrease in capacity.

Ice trouble in the Otonabee and Trent rivers consists almost entirely of frazil, and I believe that practically all the plants operating on these rivers are affected to a more or less extent at times by this form of ice trouble. This usually occurs early in the winter before the river freezes over and on the occasion of a sudden drop in temperature. The trouble usually disappears after a continued cold spell has caused the different reaches to freeze over.

Different methods of combating this form of ice trouble have been tried out with varying success, such as heating the racks and mechanical rakes, but we have found that in most cases with turbines having comparatively large openings and the wheel settings designed in such a way that the wheel cases can be kept at a slightly higher temperature than the freezing point, serious trouble can usually be averted by watching conditions carefully and pulling the racks before the frazil is running to such an extent as to block them up and shut off the flow of water.

# THE ENGINEER IN RELATION TO THE PROBLEM OF FIRE WASTE

By E. P. Heaton, Fire Marshal of Ontario

Before throwing on the screen the slides with which I purpose to illustrate this address, let me define the terms used in the title.

By "Engineering" you will understand even better than I, the application of the term may be very broad, covering professional advice in various specialized directions, as, for example the "Sanitary Engineer," "The Power Engineer" (covering light, heat and power), "The Mechanical Engineer" (covering also electrical conditions), and others that you will readily think of, but I use the term in its generic sense, and interpret it to apply to one who plans or superintends the construction and equipment of buildings to meet the requirements of our modern, complex civilization.

Before I conclude it is possible you may have a vision of an opening for another class, I mean the "Fire Prevention Engineer," for I believe there is a field in such a professional capacity that can be wisely and profitably exercised. As a matter of fact, I am glad that we have in association with our office a past president of your Society, and a recent graduate, who are rendering excellent service in the direction in which a Fire Prevention Engineer might profitably use his knowledge and experience.

"Fire Waste" is a subject that has been brought to your attention in your various sections through literature and instruction, and I am not going to waste your time by any extended reference to its enormity, or to its clauses. As a matter of fact, the recent graduate from your Society became associated with us because he was the prize winner in the competition conducted under the auspices of our own office. Suffice it in a word to say that we expect the year 1922 to be the worst one the province has ever experienced in regard to its inexcusable loss by fire, apart altogether from the waste in our natural resources, in the bush, and in the forest. Probably we shall reach the extraordinary total of twenty-two million dollars as the year's fire waste, and it is in consideration of the engineer's relation to that fire waste that I want to say a few words.

The "Problem" centres around two distinct features. Our statistics show that out of about 10,000 fires in the province, costing, as I have said, some twenty-two million dollars, about one hundred fires are directly responsible for one half of the sum total of all the losses. In other words, the big fire carries its own problem.

The second feature is found in the commonly-called "Exposure Fire." In normal years we generally understand that from 15 to 20% of the aggregate fire waste arises from fires in neighboring buildings, or from outside exposures. Owing to the conflagration in Northern Ontario of Oct. 4th, the year 1922 will be specially marked because the ratio of the exposure fires for that year will be between 45 and 50 per cent. We must, however, for obvious reasons, eliminate the Northern Ontario conflagration from consideration and revert to the common experience that about one-fifth of the loss is due to some exposure.

It is with particular regard to the latter feature that I want to throw some slides upon the screen to illustrate and enforce the engineers' relation to a particular feature that will there be brought out, and I will reserve further comment upon the subject until the slides are presented. I may, however, very frankly and candidly admit that the fire waste problem in its broadest sense, and in its restricted application to the exposure fire, can only be solved by the engineer, and to him is not only given the necessity but the opportunity for attacking it and overcoming it. The history of the engineers' work in relation to Fire Prevention is so romantic that I could occupy much longer time than I have at my disposal in picturing it to you, and yet I must briefly bring it to your attention. Some 75 or 80 years ago the cotton mills of New England were burning so frequently that fire insurance upon that class of risk was exceedingly difficult to obtain, and when obtained the high rate charged because of the hazard almost made it prohibitive, consequently the mill owners associated themselves together for the purpose of endeavoring to determine why fires were so frequent, and how they should be met. It was readily ascertained that very many of the fires came from the picker and carding machines, and at once the engineer's answer was, that being the case, we will segregate these hazards, and put them in separate buildings where, when fire does ensue, the rest of the property will not be endangered, and the fire loss will be comparatively light; and one fundamental requirement to-day of all cotton mills is the isolation of the picker house, and the protection at all events of the carding machines.

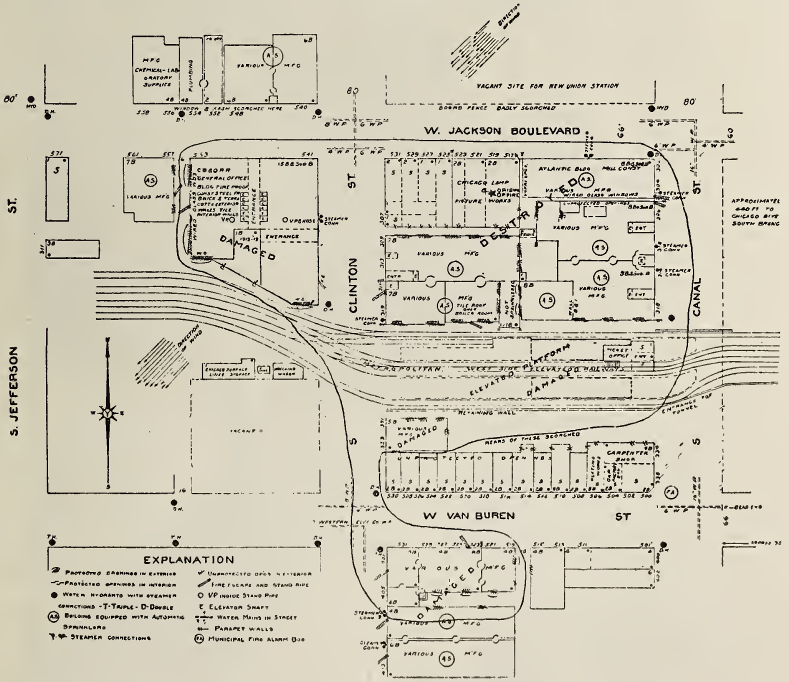
At this point Mr. Heaton related Charles Lamb's inimitable and satirical essay in "Roast Pig" and used it as an illustration that may possibly have been drawn from the occurrence of the uniting of the New England cotton mill men to meet the special conditions that were arising in their business. From the gathering together of the mill owners there arose the organization of what is known to-day as the New England Mutual Insurance Companies, the basis of which is engineering service to prevent fires, and Mr. Heaton spoke of their marvellous record and development, featuring the introduction and perfecting of protection by the automatic sprinkler. To demonstrate the efficacy that the automatic sprinkler had reached, there were three distinct periods in the general practice of the insurance companies, the first period running from 1850 to 1875 when automatic sprinklers had just been introduced, but when few installations had been made. In that period of 25 years the loss by fire to the insurance carried was .25c per $100. The next period was from 1876 to 1895 when the automatic sprinkler was becoming more generally recognized, and where many installations were being made. In that period, with four times the amount of insurance at risk the fire loss was less than three times the amount in the preceding period, and the average cost was 18c per $100. The third period was from 1896 to 1921 during which period the senior Mutual Insurance Companies had made a rule of complete and thorough protection of all buildings by the automatic sprinkler. In that period with six times the amount of insurance in force, or, as I may say, six times the liability, the fire loss was just one-third more than it was in the previous period, and the average cost reduced to .04c per $100, a marvellous showing, considering that in that period the amount of insurance was nearly ten billion dollars, due entirely to the work of the Automatic Sprinkler Engineer.

I would like to trace for you the origin and development of the N.F. P.A., who last year celebrated their 25th anniversary, an association of engineers who have throughout given their time, voluntarily, to the preparation of proper standards of engineering in building construction, and in the use of mechanical appliances, and if I had time to dwell upon the intensely interesting history of this Association, it would, I am sure, appeal to you as placing a halo of glory on the heads of the men who have so faithfully, without remuneration, and unstintingly given their time to the work.

I think I may state a truism that you will all accept when I say that the scientific achievements of the last half century have been remarkable in extent and in their benefit to the people, and yet, it is equally true, that in nearly every case the achievement has produced a corresponding fire hazard. Take for example the prevalent use of electricity for light, heat and power, and you all know what hazards have necessarily been met with in the processes and in present day usage. Take again the very common use of the automobile and the motor car with its necessary corollary, in the use of the highly explosive and volatile substance of gasoline. So I might go on and quote other instances, but these are enough to illustrate the statement I have made and also to justify the further statement that the engineer has controlled and safeguarded the hazards as they have been met with, one by one, until it may be fairly said that the involved hazards have been brought into subjection and control, and the fire hazard reduced to a minimum, if not practically eliminated.

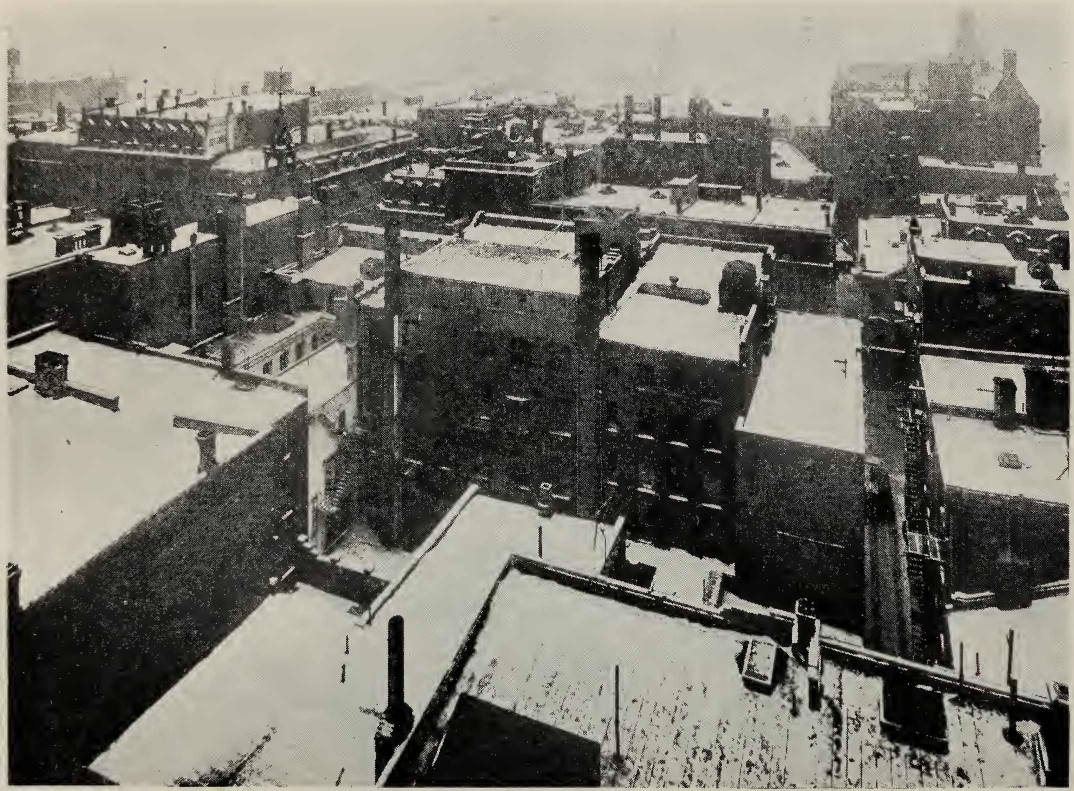
Chicago Fire—March 15, 1922

Reverting for a moment to the definitions with which I started, the big fire necessarily arises because of the big plant. These are days of concentration of values, of combination of forces when under one roof must be gathered enormous values. Again, the concentration of population in our urban centres and the enormous increase in land values has necessitated building in the air, and we have the skyscraper. In the course of the last 50 years engineering skill has practically produced the skyscraper, safeguarded in construction and protection to the highest degree, and if on March 14th, 1922, I had asked if a fireproof building had been designed and erected, the answer would have been, "Yes, many of them," and if I had gone to Chicago and looked at the office building of the Chicago, Burlington and Quincy Railroad, and had asked if that could be taken as a typical illustration, the answer again would have been, "Yes," for if there was one building in Chicago, which, by reason of its construcion and occupation was regarded as a fireproof building, that one was so regarded, but on the 15th March, 1922, the belief had been shattered, for on the early morning of that day this particular building was practically destroyed by fire, at all events, from the 8th storey up, at a loss of considerably over one million dollars, and I now purpose throwing on the screen some pictures taken before, during, and after this fire, that they may bring home to us the fact that we have not yet devised an absolute fireproof building, and that we shall not do so until the control of the fire from without, (the exposure fire) has been brought much nearer to perfection than it now is. In this fire twelve buildings were destroyed with a loss of from five to eight million dollars; seven were of four storeys or less; one was of seven storeys in height; three of eight storeys in height, and one, the particular building already alluded to, the Burlington Building, of fifteen storeys.


W. JACKSON BOULEVARD
VACANT SITE FOR NEW UNION STATION
BOARD FENCE BADLY SCORCHED
DIRECTION OF WIND
S. JEFFERSON ST.
CLINTON ST.
CANAL ST.
W VAN BUREN ST
DESTROYED
DAMAGED
CB&QRR GENERAL OFFICE BLDG FIRE PROOF
ATLANTIC BLDG
CHICAGO LAMP & FIXTURE WORKS
VARIOUS MFG
METROPOLITAN WEST SIDE ELEVATED RAILWAY
ELEVATED PLATFORM DAMAGED
RETAINING WALL
CARPENTER SHOP
APPROXIMATELY 680 FT TO CHICAGO RIVER SOUTH BRANCH
EXPLANATION
Protected openings in exterior
Protected openings in interior
Water hydrants with steamer connections -T-Triple - D-Double
Building equipped with Automatic Sprinklers
Steamer connections
Unprotected openings in exterior
Fire escape and stand pipe
VP inside Stand Pipe
E Elevator Shaft
Water Mains in Street
Parapet walls
Municipal Fire Alarm Box

Burned Area—Chicago Fire.

Reference to the following diagram will show the area of the fire in question. Nothing is particularly asked to the fact that the Burlington Building, shown on the west side of Clinton Street, fronts on a street 80 ft. wide, and the marvel is, how the fire crossed that street. We can understand how the fire spread from the small old buildings facing on West Jackson Blvd. because of the nature of their occupancy, but it is not



View Showing Danger of Present Situation in Toronto easy to understand how fire got into the buildings to the south, which were protected as a rule by automatic sprinklers. I want, however, particularly to draw your attention to the number of narrow alleyways having exposed windows on each side, which doubtless afforded a ready spread for the fire.

The entire easterly facade of this building facing Clinton Street had the usual wooden window frames with windows of the ordinary glass. Wired glass windows were introduced in the Lightwell, and also on the west side to take care of the exposure from that side, but in view of the width of Clinton Street no such precaution was taken there. The fire started in one of the small buildings, as is shown on the diagram, at about 12:45 a.m. on the morning of March 15th and by 2:45 a.m. the Burlington Building had also been practically destroyed, as will be shown in the next picture.

Evidence shows that fire did not travel directly to the Burlington Building, but that radiant heat, and it must have been enormous, got through each of the upper storeys from the front to the rear and caused utter destruction on all floors above the 8th.

I have spoken of wired glass because up to this point it has been generally conceded that metal window frames in which wired glass was inserted formed reasonably good protection against any ordinary or even a severe fire loss, but in the case of the Burlington Building it has been shown that where wired glass was introduced the panes were of too large a size and that they, at various points, yielded to the pressure and to the force of the flame from inside, and disintegrated. Without enlarging on the circumstances that are so clearly shown in this picture, it is fitting that I should pause to ask how such a condition as is here represented, can be met and overcome.

I have had a number of pictures taken in the City of Toronto, and will throw them on the screen, where serious conditions of exposure exist, but in this paper there will be only one inserted and that was taken from my office window.

If you will notice the narrow alleyways, the exposing rear windows on nearly every building, you will see a spot in Toronto where there is an easy path for a spreading fire. It was just such conditions as this that caused the last Toronto conflagration, and not only in this case, but in many others, are we liable to have a recurrence because of the exposure from unprotected windows and doors, and here you have the problem of the engineer in relation to the fire waste, which I must leave with you for thought and consideration.

In closing may I mention that on the facade of the great Union Depot at Washington, D. C., there is a panel dedicated to the god of fire, upon which there has been inscribed by a well known artist, this motto:

"Greatest of discoveries enabling man to live in various climates, use many foods, and compel the forces of nature to do his work."

Yes, fire is a good servant but a bad master.

# PROBLEMS OF TOWN PLANNING*

By Horace L. Seymour, C. E. (Tor.)

"Town Planning is the scientific and orderly disposition of land and buildings in use and development with a view to obviating congestion and securing economic and social efficiency, health and well being, in urban and rural communities."—Definition approved by Town Planning Institute of Canada.

"Make no little plans; they have no magic to stir men's blood and probably themselves will never be realized. Make big plans; aim high in hope and work realizing that a noble logical diagram once rendered can never die but long after we are gone will be a living thing asserting itself with ever growing insistency. Remember that our sons and grandsons are going to do things that would stagger us. Let your watchword be order and your beacon beauty."—Daniel H. Burnham.

Every municipal engineer should understand the principles of town planning and should be more or less familiar with its technique. For a successful civic development the city engineer should be a city planner.

### History and Legislation

Town planning has been described as both a science and an art. As an art it has been practiced for centuries, as a science, merely with the century. Raymond Unwin tells us that the first historic case of town planning is that of the town of Kahun, in Egypt, where 3,000 years B. C. the town was built to provide for the needs of workers on the pyramids being constructed in that vicinity. Since that early date many examples might be cited of the practice of the art of town planning and would include the names of many ancient and modern towns and cities.

One of the evidences that town planning was becoming not merely an art but also a science is found in legislation in the sixties of the last century in such countries as Italy, Sweden and Prussia. Some of this legislation dealt largely with the matter of expropriation of land by which a community could provide for street widenings and extensions or other changes of advantage to the community. In most countries the power of the state in this regard is now generally recognized and upheld by law, but, up until a few years ago at least, in the city of Vienna for example, no property could be taken by the city without the approval of the individual. The providing of legislation, therefore, in the early period of the latter part of the 19th century was a considerable advance and permitted town planning to be treated from a more scientific standpoint than in the past. Most countries in the world have certain measures of town planning legislation either in force or being considered.

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* Based on a series of lectures delivered to Fourth Year students in the Municipal Engineering Option, Easter Term, 1923.

Canada has been more or less influenced from two sources, these being the United States and Great Britain. In the Old Country town planning has been regarded largely from the health and housing standpoint and the British housing and Town Planning Act of 1909 grew out of previous health legislation. It did not provide for expensive corrective measures in the areas already developed, but it did endeavour to prevent the making of mistakes in new or only partly developed areas surrounding older development. The amended Act of 1919 gave town planning a wider scope and made the preparation of certain town planning schemes compulsory.

### American Developments

In the United States, Washington, the capital city, is a happy example of the earlier town planning art. A certain phase of town planning received a great impetus at the Chicago World's Fair in 1893. Here the wonders that might be accomplished through studying groupings of buildings were made apparent. There arose the idea of the civic centre, which has been of value in the development of the United States. It has also been detrimental in some instances to the idea of town planning in that it introduced an almost prohibitive expense to the average developed town in taking the necessary corrective measures to provide for a suitable civic centre.

Since then there has been developed very widely the idea of zoning, which is an important part of city or town planning and which, as opposed to the civic centre, is comparatively inexpensive to put into operation. In 1908, Alameda, in California, put into effect an ordinance under which the use and other characteristics of a building could be controlled. In 1916, New York, the largest city in the United States, put into effect an ordinance and since then hundreds of cities have followed the example or are considering doing so. In our understanding and outlook of city planning we are undoubtedly influenced by what is happening in the United States. In all but two provinces in Canada there is legislation of more or less town planning value. In such provinces, as a rule, the acts have followed largely the British Acts of 1909. In Ontario there is a Planning and Development Act which is an amendment of the Cities and Suburbs Plans Act of 1912, which was enacted largely through the efforts of the City Guild. There are numerous other Ontario Acts, but particularly the Municipal Act which contains town planning provisions applicable, as a rule, through municipal by-laws.

Frequently settlement preceded surveys, while now surveys, with few exceptions, precede settlement. Both the methods and the inaccuracy of early surveys were shown to have an effect on the present problems of town planning. Some of these effects are jogged and irregular streets; difficulties of opening up new streets through badly surveyed areas and difficulties in planning, due to the fact that original surveys were generally made without regard to topography. It was shown that in some early surveys the areas were laid out by settlers themselves. In New Brunswick and Nova Scotia it was difficult and often impossible to find original survey monuments. The original surveys of Prince Edward Island, although magnetic, were well executed.

An interesting example of early radical planning in the Province of Quebec was illustrated at Charlebourg and vicinity, near the City of Quebec. While under French domination, there was an endeavour to provide, what has been so often mentioned, as very desirable, a village or centre with farms radiating therefrom. As a rule, however, we find the early farms of great length have been divided into narrow frontages, especially those on the St. Lawrence River. Townships now surveyed in that province are ten miles square with boundaries, north, south, east and west. The principle of long, narrow farms is still continued as having the advantage of close settlement. The result claimed is, that in Quebec, people do not leave the farms as in some provinces, where the method of survey has separated the settlers to a greater extent.

In Ontario there have been various systems and also a lack of system in township surveys. In the early days farms were granted or conceded along rivers or lakes. As settlement was forced further back from such main topographical features, the best means of transport in those days, further ranges of "concessions" were surveyed. The more recent system of surveys in Ontario have been the six mile and the nine mile townships.

Tribute should be paid to the manner in which township surveys are now carried out by the Dominion Government in Western provinces. Suggestions have been made for changes in the method of survey, which would make them as desirable for settlement as they are now excellent from a geometrical standpoint. In British Columbia it was shown that in the more mountainous country, lands were staked out very similar to the staking out of mineral claims.

In Western Canada out of over 200,000,000 acres of land surveyed, there was a few years ago but 20,000,000 acres under crop, while within twenty miles of a railway there were 15,000,000 acres of vacant land.

## Zoning

The term "zoning" is derived from the practices of the walled cities of Europe where the existence of arbitrary authority made it possible to carry out stringent regulations with respect to the character of the different parts of the city, various areas being actually in the form of a zone. In America, zoning might better be termed "districting or delimiting" as the areas to be regulated are not necessarily zonular in shape.

Zoning has been defined as public control of private property in the interest of the health and welfare of the people and as the determination of the character and intensity of the use of land, and more specifically as the control under community power of (a) the height of buildings and (b) the percentage of area of lots that may be covered with buildings and (c) the use to which buildings may be put on private property.

The advantages that have been ascribed to zoning include the following: (1) Permanent development of the area concerned; (2) provision of adequate light, air and sanitary arrangements; (3) orderly growth of the city; (4) prevention of undue congestion; (5) stability of property values; (6) saving in the cost of construction of service utilities.

In a restricted sense the term "Town Planning" is generally considered to mean the public control of what is, or what is to become public property. As applied to cities it has been considered to include, for example: The street lay-out; sewerage system, water supply; transit and transportation system; port and terminal facilities; park and recreational system; location of public buildings. But public property in the average city or municipality constitutes but one-third of the area in street, parks, etc. From over one-half to two-thirds is private property. Zoning is that part of town planning which has particular reference to the public control of private property.

### Advantage of Zoning

The advantage of zoning is generally considered or it might be said is popularly considered, to be that of the protection of residential areas. There are advantages easily recognized by all those who enjoy home life. It is easy to fall into the error of unduly emphasizing this phase—the protection of the home being a popular appeal. While this is undoubtedly one of the aims of the town planner, he has other important and fundamental aims—the protection of the factory and factory sites; the protection of the business and business sites. The answer to "Why is a city?" or "Why is a town?" must be in general a commercial or industrial one. First of all there must be considered the location of industries and the protection of industrial sites. Then the location of business and the protection of business sites and finally the location of residences and their protection from the unnecessary intrusion of industries or business. Every zoning scheme must include the provision of an adequate transportation system to link these areas of various uses together. Scientific zoning means co-ordination not segregation.

### Planning for Sunlight

Various disease bacteria, such as typhoid, tuberculosis, etc., which can exist even for years in dark places, succumb to direct sunlight, of from a few minutes to an hour. Of particular importance in this regard are the matters of orientation of houses, disposition of rooms and the location of windows and verandahs.

For the free standing house, charts and diagrams may be made to show that the orientation most desired is that when the faces of buildings are not square with the cardinal points but at an angle of 45 deg. therewith. For streets in residential areas, the desirable direction is generally that of north-east, south-west and north-west, south-east, especially if blocks are square and not long and narrow. With high buildings on long, narrow blocks, the north and south street is shown to be the best street for main development. Ideally planned, the sunlit city would have a gridiron of long narrow blocks running north and south for the business section, surrounded with a checkerboard of residential streets radiating diagonally from a central development.

For the provision of sunlight as well as for other important reasons, the general rule is that the height of buildings should not exceed the width of the street or the distance between buildings.

### Practical Examples

A parallel may be drawn between the city of Halifax and the town of Haileybury in regard to the physical location and the disasters which called for the solution of problems for rehabilitation. These offered an unusual opportunity for replanning.

In the Halifax disaster of 1917, funds were made available for, and sufficient powers vested in the Halifax Relief Commission, so that all residents suffering in the disaster were reimbursed for losses and were provided with temporary shelter in the form of rows of frame houses in various parts of the city, but *not* in the area which was being replanned for future occupation. This was a comparatively easy solution of the problem, but such treatment was not possible in Haileybury. No immediate fund was available to meet private losses, but lumber for temporary shelter (a "shack" 16 by 20 ft.) was being provided by the Relief Organization. It was necessary and reasonably so, that an owner should be allowed immediately to erect a shelter on his own lot. Building permits issued however, have been almost entirely for temporary buildings to be renewed or made to conform to building by-laws in force on the 30th October, 1923. In many cases the owners, who must keep their temporary buildings in ordinary cases at least 20 ft. back from the street, are putting them back further to be used as kitchens when the permanent house of the future is erected.

In considering the problems of planning in Haileybury, the relation of Haileybury and its urban zone, and its relation to adjacent towns with their urban zones, must be understood. The lack of proper topographical maps hampered the work to no small extent. Council by-laws provided for fire areas and the segregation of residential from busniess, warehouse and factory sites.

# *Old School*

## 1891 — 1901

"School!!!" And 800 *enthusiastic* engineers rend the heavens with a "Toike Oike" that leaves in oblivion more intelligible yells.

"School!!!" And 800 *excited* engineers are on their toes, thirsting for Meds' blood and Arts' gore.

"School!!!" And 800 *enraptured* engineers cheer on that loyal team to victory.

"School!!!" And 800 *enthused* engineers uphold the honor of the Blue and White.

"School!!!" And 8,000 *eminent* engineers from every clime, country and calling, look back with love and loyalty upon that "Old Red School House."

What is this intangible yet intrinsic and dynamic feeling that lays hold upon our innermost beings by those two words "School Spirit?" What is the reason for this friendship and fellowship, this inherent affection so symbolic of "School" men, graduate and undergraduate? Does it not find its origin 'way back in the olden days; 'way back in the years that have produced some of the most illustrious engineers and leaders in our Canada and other nations? We are proud to uphold the traditions, the ideals and loyalty to our Alma Mater, handed down to us from our engineering forefathers. We cherish the memories and the successes of those men who not only brought into existence this "School" and "School Spirit," but who have gone out into the world and laid the foundations for that practical science upon which we aspiring students hope to build.

Now let us turn back to those pioneer days. Let us have a squint at some of those prominent engineers at School. From our humble and inexperienced position we look with awe upon their successes and accomplishments and we often wonder to ourselves just what they were like in their youthful days. Did they participate in some of our spirited but foolish antics? Were they always getting into trouble with other faculties, the S. A. C. and the "powers that be"? Did they experience the same reluctance to arise for those nine-o'clock lectures? Did their thirst for knowledge overcome that welcome for the minute hand's arrival at the hour?

As we were saying—from our humble and inexperienced position we are inclined to wonder. Let us see:

### A. T. Laing—'92

When the class of '92 knocked at the door of the little "Red School House" for admission there were twenty-eight in all, constituting the largest class up to that date. The ever-watchful and faithful servant "Prof." Graham was on hand to extend a word of welcome, the usual salutation being, "Well, young man, what are you doing around here?" delivered in such stern tones and in such an authoritative manner that the timorous freshman felt certain on the outset that no liberties could be taken with the caretaker. It was soon realized, however, that he was not only the faithful servant but also a good-hearted friend of the students. He was a living part of the old school and the students from year to year for many years gave tokens of their appreciation of his character and many kindnesses. His old friends will be glad to know he still enjoys life in retirement.

Matriculation, at this time, was not a prerequisite to admission, but the applicant was supposed to have a certificate from a high school master of good character and a statement of the advanced work he had covered. Failing this, he was asked to have a quiet talk with Principal Galbraith, than which some declared they would have preferred the matriculation examination, but it resulted usually that none who were really in earnest were turned away.

The class comprised representatives from nearly every walk in life, and it was claimed by one member that he could discern from the vernacular the environment from which each had come; the son of the soil drew his illustrations from farm life and so for the son of the tailor, the merchant, the physician, and we may be pardoned if we omit here the language of the lads from the parsonage. But there was one about whom there could be no conjecture in this regard, the seafarer. The deep sonorous voice of Virgil Marani was like the sound of many waters, at times thundering and tempestuous. His language at times was, perhaps, more forceful than elegant, but it was direct and unambiguous, and was profusely punctuated with the phraseology of the sailor. His spellbinding stories of life at sea made him very popular. It is no reflection on students of the present day to say that seriousness and definiteness of purpose was, perhaps, more in evidence than at present, due no doubt to the fact that the average age at entrance was about 22 years as compared with 19 years at present.

There was no rendezvous for students, no supply department by the Engineering Society and the library of the Society, still in its infancy, was cradled in a small room adjoining the furnace room in the basement. Having outgrown this space, room was provided on the top floor and the students were assigned the task of moving. It consisted of about one trip for each man carrying one book. It is interesting to note in passing that the only smoking then was indulged in by the caretaker, who confined his operations to the furnace room and took great pains to see that the furnace was an efficient smoke consumer.

An interesting feature of each session was the opening meeting of the Engineering Society which took the form of an experience meeting, the students giving an account of their summer's work. On one occasion a student who had a reputation for a disregard for personal appearance and an aversion to bathing, related how he had had to chain through water well above the waist. Some doubt was expressed as to his statement, but a friend vouched for him, stating that he had seen the high-water mark.

One event which overshadowed all others in magnitude and importance was the disastrous fire of February, 1890, which destroyed the east wing and the greater portion of the front of the University. It was a staggering loss, including as it did many valuable records, an excellent library, many volumes of which could not be replaced, as well as a costly building. It was on a night set apart for a Conversazione, which was an annual affair and was the one and only big event of the session—how different now. The School was assigned a room for display and this was suitably fitted up, representing in one corner a surveyor's camp and about were instruments, chains, pickets, etc. The walls were decorated with many *beautiful* and *valuable* drawings of the first year. All was a total loss and the poor students received no consideration except that no one was plucked in drawing that year. Up to this time the rooms of the University were not equipped even with gas fixtures and for special occasions lamps had to be borrowed and mounted on improvised chandeliers. The origin of the fire was due to the carelessness of a servant who, while placing some of the lighted lamps, upset one amongst a lot of others and all burst into flame. The point at which the accident happened made immediate extinction with the means available impossible. The facilities for fighting fires from without were entirely inadequate and before the fire could be controlled the building was in ruins.

The next noteworthy event was the construction of the southerly portion of the present Engineering building to meet the growing demands for space. The building was completed during 1891 and to celebrate the occasion a formal opening was held January, 1892. It was an auspicious occasion. The whole building with the newly-equipped laboratories in Mechanics of Materials, Hydraulics, Electricity and Thermodynamics, etc., were thrown open to visitors and the budding engineers of the graduating class shone forth in great splendor as, arrayed in blue jean overalls, they operated the machines which they understood little better than did the spectators.

The new building, on account of its outlines, was not considered a thing of beauty and went under the name of Galbraith's Factory. At a University convocation held in the present first year drafting room in 1891, the then chancellor, The Hon. Edward Blake, congratulated Principal Galbraith on the expansion, and particularly on the establishing of a department of architecture, stating that there could not be a better place for such a school. In the University building was something to inspire and to be emulated in design, while in the new school building was something to be avoided.

During the years to which this brief sketch applies, there was a growing demand on the part of the students for recognition other than that set forth in the graduation diploma. It was urged upon the Faculty Council that there should be a degree established. The council was sympathetic but it did not have degree-conferring power. An arrangement, however, for such recognition was brought about by the council with the senate of the University whereby in January, 1892, the degree of Bachelor of Applied Science (B.A.Sc.) was established. The requirements of a candidate for this being that he should hold the diploma of the School of Practical Science or be of fourth year standing in the honor department of Chemistry and Mineralogy of the University of Toronto. The session 1892-93 saw the first class registered in what was called the post graduate course leading to the B.A.Sc. degree. The class consisted of eleven men, eight of whom were from the class of '92 and three from previous years, and all were successful.

One cannot close without reference to the two outstanding figures, the late Dean Galbraith and his intimate friend and colleague, the late Dean Ellis, men of widely different characteristics but in a remarkable way the one the complement of the other, men of surpassing ability and attainments in their respective fields and who found at the same time an abiding place in the esteem and affection of all students. Their aims and objects were to build up an institution worthy of the name and to aid all who sought its benefits, and their achievements in these respects are at once a challenge as well as an inspiration to all who follow. Their memories are cherished by all who came under their influence.

"When great men die,
For years beyond their ken
The light they leave behind them lies
Along the paths of men."

A. T. LAING.

## C. E. Langley—'92

My first recollections of the "Old School" began with the curiosity excited by that wind gauge affair which used to spin and glitter above the skyline, and which could be seen from the dog-pond where, as kids, we used to sail our toy boats. Perhaps there was a subconscious determination even then, to learn, some day, what went on inside those red walls.

That "dog-pond" was then a picturesque institution in Queen's Park—Toronto's Serpentine, in fact. A little lake formed by a high dam across the creek at the eastern entrance to the campus; and so, just south of where Hart House now is. "Musk Rat" I think the creek was called, but this may be checked by a reference to our freshman's survey drawings of '88; for as fate would have it, this very spot, drained by scientific vandals, was chosen for us surely out of pure cussedness like lots of other things because hard to get right, as a fitting place for wee Davie Burns to put us over the bumps with the instruments.

About this time it seems to have been realized to some extent at least, that the fine Arts had, as a matter of concern for the University, been neglected, and in '89 the Architectural course was started. C. H. C. Wright for staff; yours truly for class. It is a matter of pride with my mother-in-law to show the newspaper clipping indicating my standing: No. 1 in every Architectural subject. This course has gone steadily forward, as we all know, until now it is to be reckoned with and a justified cause for pride. Naturally it can yet go far, and besides furnishing professional education, be a great factor in the necessary cultivation of, and general appreciation in fine Arts, by people who call themselves well educated.

The fine Arts of a nation might well form a better skeleton than Kings and dates on which to hang history: and general cultivation and appreciation is necessary if Canadian Art is to take its proper place. It is food for thought that so few, even leaders, have any knowledge of the eternal fitness of things in matters of beauty. Perhaps, some day, it will not be optional to remain ignorant on these things.

I seem to have got away from the few little recollections I had intended to put down, and now I have taken up much more space than you wish me to occupy.

I might have mentioned the distinction S. P. S. had in the fact that it was our assistant janitor, "Game" Goodwin, who dropped the tray of oil lamps in the East Wing and so thoroughly set fire to University College the night of the Conversat. We did our best to kill "Game" at Wellesley School when boys, but he was destined to a higher end.

There was a splendid demonstration of cultured boneheadedness at the fire, suggesting "presence of mind" as a compulsory study: the recklessness with which the mattresses and pillows were carried down stairs from the residence, and the care exercised in hurling carefully articulated skeletons from the museum windows, was truly beautiful in a cubist way of speaking.

Another regrettable incident: when the sodium exploded and Dr. Pyke's eye was hurt. We didn't realize that at the time, and were only vastly entertained at Jo Jo Bonstead, his assistant, who seemed mortified, knowing that sodium shouldn't kick up in that way, properly handled.

C. E. Langley.

## Walter J. Francis—'93

In order to appreciate this little story of my years at the School, you will have to move your mind back thirty-four years—a rather long period to look forward to but very short in retrospection—for I entered the School in 1889. In those days things were different from what we have them now. That was before the electric street cars. Horse-cars and stage coaches ran on Yonge Street then, and I remember the stage coaches used to be parked in front of a tavern on Yonge Street just opposite where the Simpson store now stands.

My rector at the old Grammar School had told me of the glories of architecture, and I went to the School to look for an architectural course. There was none. I was enrolled with the Civil Engineers of '92, and I took some extra lectures to help fit me for the architectural profession.

Varsity was very different from what it is now. The Main Building stood in solitary majesty beside the beautiful campus which was the pride of all Toronto. It was the only important building then standing of the whole University group. Taddle Creek meandered down the valley which is now usurped by Hart House, the Library, the Medical Buildings and the Biological Building. The School was a lonely red brick building nestled beneath the great elm trees still standing and next to the high garden fence of the Observatory, in which grounds the Weather Man—the same old Weather Man, but he was not Sir Frederick Stupart then—had all his mysterious little structures used in making the weather. The main building of the Observatory stood in what is now the middle of the street leading from College Street up to the Main Building. It was moved and re-erected stone by stone on the site it now occupies near the Main Building. I do not remember what was on the other side of the School building, excepting that there was some broken ground and Wycliffe College stood facing on College Street. The School building as we knew it was that part which now forms the north wing of the present red brick building. The front door faced on the campus. Above its lintel were engraved mystic characters forming words. Perhaps you have never appreciated that doorway. While it is not so beautiful as many of the other University portals, it is, nevertheless, beautiful because of the memories which surround it. There was one wing of the Biological Building completed—that part with the semi-circular end on it. The little red brick Y. M. C. A. building, with its single polished granite column at the entrance, occupied a prominent place at the front entrance to the grounds from College Street.

The old School building, small as it was, was more than sufficient for the needs of the school, the activities of which centred on the middle floor. There were three professors—Professor Galbraith, Professor Ellis and Professor Chapman. Mr. L. B. Stewart was lecturer in surveying and there were two other junior members of the staff. Mr. Stewart was also the secretary.

I recall very clearly that R. A. Ross, of Woodstock, now Dr. R. A. Ross, of Montreal, was the only student in mechanical and electrical engineering. He used to take a number of his lectures all alone in Professor Galbraith's room. When he came out he looked so wise that we all wondered whether there was room for another idea in him. Up to this time there had been only about fifty or sixty graduates of the School, and we had all heard of Morris and Tye and Duggan and Thompson and

Haultain, but few had the opportunity of making their acquaintance personally. C. H. Mitchell, now Brigadier-General Mitchell, the Dean, was a member of the class of '92. He knew the ways of Varsity better than the rest of us because of his having been a year or two in Arts before he entered Engineering, and we all appreciated his superior knowledge and experience. The Engineering Society was flourishing then in the fourth year of its existence. It was founded two years before the Canadian Society of Civil Engineers, and H. E. T. Haultain was the first student president. Before his time Professor Galbraith occupied the presidency of the Society.

All these things were before the days when School men counted on the Varsity multitude. We took a lot of our lectures in the Main Building—Sir Daniel Wilson was president then—and sometimes we had lectures from the University professors who came to the old building. John A. McGowan, now Professor McGowan, gave us our lectures in trigonometry, while Professor Alfred Baker, his senior, delivered the lectures on calculus.

Probably the outstanding event of that first year was the disastrous fire in the Main Building, when the greater part of the front and the whole of the east wing were completely gutted. During the afternoon I had been helping with the decorations for the Conversazione to be held in the evening. On my way home at dusk I saw the reflection of a great conflagration, not dreaming at the moment that it could be the old building of which we were all so proud. It seems an oil lamp had been upset and had ignited some of the decorations. The east wing, by the way, used to be Convocation Hall, with the basement of which sulphurous fumes and muffled groans of the freshmen used to be associated.

I was deeply impressed with the first Literary Society election I attended. It was in a hall downtown—I forget where. The most important duty that any student had was to cast his vote, and I remember I succeeded in exercising my franchise at about three in the morning, after which I returned home sore but satisfied, minus a coat sleeve and most of my buttons.

The glamour of architecture faded when I learned the prospective wages, and having obtained a position on the construction of the Toronto Belt Line Railway during the vacation, I thought I developed a liking for engineering, so in the autumn of 1890 I returned and entered regularly as a freshman in Civil Engineering. That was the year when the remainder of the old red school house was put into commission. It had been finished during the vacation and we took possession in October. Professor A. P. Coleman took the place of Professor Chapman, and Professor Galbraith and Professor Ellis continued as before. Mr. C. H. C. Wright and Mr. T. R. Rosebrugh, both of whom have since been elevated to the professoriate, were added to the staff, and Mr. Wright had charge of the newly-formed architectural course. The first year of the '93 class began the crowding habit that became so marked at the old School twenty years later. But the years succeeding '93 were much smaller, and, if I remember well, '93 was the largest year of all until the graduates of 1900 or 1901 were turned into the world. We had with us J. M. R. Fairbairn, now Dr. Fairbairn, the chief engineer of the Canadian Pacific Railway, and L. C. Charlesworth, now Deputy Minister of Public Works of Alberta, and N. M. Lash, now chief engineer of the Bell Telephone Company of Canada. We also had Frank N. Speller, the great authority on the manufacture of steel tubes, as well as many others I could mention. Our ways were pleasant ways, and there is not one who does not smile to-day when he thinks how Nor. Lash could walk on all fours, and how Virgil G. F. Marani was always "the life of the party." Then, just as for twenty or more years to follow, as regularly as the evening came we heard the familiar voice of Prof. Graham ring out "Five o'clock, Gentlemen!" and we left the rooms reluctantly.

In speaking for myself, I formed associations and friendships in those times which have become more firmly cemented as the years have rolled by. There are five of us—all old Toronto boys—in Montreal, where we have been for years. Although relatively large in numbers, our professors knew us individually. The culture and manly charm of Dr. Coleman were appreciated by all, and when Dr. Galbraith and Dr. Ellis graduated into the Greater University I felt that I had indeed lost two very close friends.

Many of the old-time students I have mentioned are known throughout the length and breadth of the land and have attained positions of importance in the community. The profession has not failed to recognize their worth and interest, for Mr. Tye, Mr. Duggan, Mr. Ross and Mr. Fairbairn have all been honored with the presidency of the body which represents the engineering profession in Canada—the Engineering Institute.

I like to go back to the old place—indeed, I do go back every time I can find a reason, or, more properly speaking, an excuse to do so. It is most refreshing to talk for a while with those who were there when I was, and it is very pleasant to recall old times and still more pleasant to renew old friendships.

Yours very truly,

WALTER J. FRANCIS.

## L. C. Charlesworth—'93

The freshmen class of the fall of 1890 when I started in at the Old "School" was, I believe, much the largest in the history of the school up to that time, and was so much stronger numerically than the second year that we practically all escaped the "hazing" that according to time-honored traditions we should otherwise have received.

It was, I believe, the first year that the enlarged building was put into use. Prior to that time what was the north wing of the new building had comprised the whole "School." The new first year draughting room, which had probably been designed to take care of the expected increases for some years to come, was well filled by the large freshman class.

That, too, was I think the year that C. H. C. Wright, who had graduated with high honors a few years previously, joined the staff. The other members of the staff were "Johnny," "Louis B.," "Doc. Ellis," "Chappie," "Rosebrugh," "Duff," "Cæsar Marani" and "Five-o'clock-gentlemen Graham." Dr. Coleman came a year or so later.

Among the students in the second year was the present Dean, "Charlie" Mitchell, and he was, I think, one of the first outside of our own class with whom I became acquainted. This acquaintance was the result of a transaction which was very satisfactory to me and probably just as much so to him. By it I acquired some second-hand text books at reduced prices. Deacon and Dunbar were also there and the boxing bouts, or rather slugging matches, between these two heavy weights certainly provided lots of entertainment. C. H. C. Wright was a fine football player (association) and the School shone in that line, Alex. Goldie and Kit Forrester of our year being prominent players. One of the best-known figures of our year was Virgil Marani, a brother of Cæsar's. Virgil, who had spent much of his life at sea and held, according to report, first officer's papers for sailing vessels and second officer's papers for steam vessels, had come in the previous year as a special student and then started as a regular student in the fall of '90. He was a striking looking curly-haired Italian with the devil in his eye, and though not tall was built like a bull and was just as strong as one. Virgil could talk at any time on any subject and loved to do it, and as he had a wonderful fund of experience and had travelled all over the world his tales were a never-ending source of entertainment. As he himself said, the more people there were observing him the happier he was. When things grew dull in the draughting room Virgil would be given a subject and called upon for an impromptu speech which you may be sure was never dull but which was suddenly interrupted and wound up with the remark, "Oh, my God! There's Johnny!" Whenever there were any grievances to take up with any of the staff Virgil was the man deputed for the job and his talk could charm fairies any time.

Literary society elections were at that time a matter of brute strength. The party strong enough to get possession of the polling place permitted none but its own supporters to vote. Needless to say, Virgil's assistance was eagerly sought by both parties each year and when stripped and vaselined for action he was a vicious looking object to tackle and helped materially to win elections. He was a prominent member of the Lit for that one evening each year.

Other members of the class were Jack Fairbairn, Frank Speller, Jim Robertson and Nor Lash, who when a lecturer happened to be late used to entertain us, and probably could do so still, by walking on all fours with his palms flat on the ground and his knees and elbows stiff. There was also Walter Francis. Francis was a beautiful draughtsman, and those being days of depression and of difficulty in getting jobs, his draughting generally gave him an entering wedge ahead of the other fellow. He has since attained an eminent position in the engineering profession and whenever I hear a student or young engineer expressing the opinion that time spent in acquiring skill in draughting is wasted and that "once a draughtsman always a draughtsman," I try to change his viewpoint. Of course, outside of the draughting altogether, Francis could deliver the goods.

For physics we had to go over to Professor Loudon in the Arts Building. The physics lectures were attended also by certain Meds. Our large class crowded the lecture room so that a number usually had to go without seats and a small sized war usually occurred between S. P. S. and Meds accordingly. In spite of this, S. P. S. and Meds would unite against Arts any time. The same condition of crowding existed in some lectures taken jointly by Arts and Meds and on one occasion an S. O. S. call came over to us from the Meds asking for assistance in a big fight over at the Arts Building. We all turned out and it certainly was a real scrap, involving practically every student in the University. Being finally driven from the lecture room and corridors by the fire hose, we repaired to the campus and kept the row up all day. Not a lecture was attended by anyone. Next morning all were surprised on arrival to see the campus and buildings guarded by a considerable squad of city police. Had this not occurred the fight would probably have been a thing of the past, but the sight of the police was sufficient to start a real row. All hands united to round up the "bulls" who soon took refuge in one of the small white brick houses which then stood near the southwest corner of the campus. The crowd surrounded the house leaving an open space in front in which Virgil stood and addressed them and the police in turn. He had a beautiful and varied vocabulary for such an occasion. What the outcome would have been it is hard to say had not Sir Daniel Wilson, the President, who was then in poor health, but intensely popular with the students, appeared on the scene. He had been summoned from home, where he was really ill, as a last resort. In a short address he appealed to us to disperse and we gave three cheers for Sir Daniel and went back to lectures while the police slid out the back door and went home.

These and similar occurrences of seemingly no importance are the things that remain as evergreens in my memory of those days and while I fear that they may prove too trivial for your own use, I send this along for what it is worth.

L. C. CHARLESWORTH,

Deputy Minister Public Works, Edmonton, Alberta.

## H. V. Haight—'96

My time at the old S. P. S. was from the fall of 1893 to the spring of 1897. Attendance was at a low point, about 125 in the whole school, I think, but the quality I think was high, as it included R. W. Angus and J. W. Bain, who were classmates of mine, and C. H. Mitchell, who was a year or two ahead. In Arts I remember seeing several times W. L. M. King, as he was then called, and I believe Mr. Meighen was also at Varsity, though I don't recall hearing of him at the time.

My most distinct recollection of C. H. Mitchell was his paper before the Engineering Society on the subject of Flying. Even then his explanation of soaring flight seemed to me to lack something, and I see now that it did not recognize the need of an upward component in the wind to render possible sustained gliding or soaring flight. Of course, at that time man had never flown.

Of W. L. M. King I remember his announcing at the sports, for which his great voice was well adapted. One theatre night, when the "Gods" at the old Grand was filled with us, King sang a solo between acts, up there in the "Gods." It was fearfully hot and King was minus coat, vest, collar and tie. A few days later I heard him sing at a concert in Massey Music Hall, very correctly attired in evening clothes.

In my fourth year about half a dozen of us chose French for our language option, and were taught by "Johnny" Galbraith himself in his big office. He knew French well, and he knew how to teach, though his methods were original, and we did really learn some French, but had considerable fun in the process. We had been over some article in the "Competes Rendus" pretty thoroughly till we knew both the French and the English by heart. Prof. Galbraith read a sentence in French and asked Bert Angus to translate. Bert had been talking to Charlie Macbeth and hadn't heard the sentence, but glibly gave the English of a sentence about a paragraph farther on. Prof. Galbraith said, "Oh, Mr. Angus, we haven't come to that yet." Prof. Galbraith's assignment of home work was to tell us to take any French article we liked, translate it into English and bring the translation. He read the translation to make sure it wasn't "Frenchy" but didn't compare it with the French. This seemed to leave a loophole, so once, I think I was the guilty one to suggest the experiment, we all decided to copy out some English article that never had been in French. It worked. Bert Angus was commended for his very free translation.

It was interesting to be at the beginning of some scientific developments. I saw a demonstration of wireless waves, Hertz waves I think they were called, when they were transmitted across the lecture room.

Some of the first calcium carbide that Wilson made was sent over for a meeting of the Engineering Society and we saw a demonstration of the acetylene light.

When the news of the discovery of X-Rays was cabled from Germany some experiments were immediately made at the S. P. S. and I had one of the early X-Ray photos.

Yours truly,

H. V. Haight.

## E. H. Darling—'98

In reply to your favors of the 4th and 18th inst., I do not know that I have much to contribute in the way of reminiscences for the year '98.

The freshman year of '95 was one of the smallest since the School began to grow. Not more than thirty-six made a start, and of those who completed their three-years' course I do not believe there are more than a dozen left. Many dropped out, some have died, and at least one of our members gave his life in France.

Being a small year we naturally did not make a very loud noise, and went through the course watching our step. There was, however, one outstanding event in the first year. Half a dozen of our men were stale freshmen, all big husky members of the football team. Their presence, I imagine, had a great deal to do with the fact that the sophomores never attempted any duckings as far as we were concerned. As they failed to do their duty in this case the said stale freshmen undertook to carry out their responsibility. Their plot, however, was discovered and while they were lying in wait in the old cloakroom in the basement after 5 o'clock in order to waylay the rest of us as we straggled in, they were suddenly surprised by the whole year descending upon them in mass. The result was a fierce engagement in which nearly all of the conspirators got the ducking instead of their intended victims.

We were told afterwards that during the height of the combat "Good Old Johnnie" walked the floor of his office wringing his hands and urging everybody to stop the fight in order that he would not have to go down and make trouble for some of us.

During our term the School won its usual number of championship matches and I believe I am correct in saying that the glorious Toike Oike first rent the air. Surely this is enough honor for any year.

Yours truly,

E. H. Darling.

## F. W. Thorold—'00

Replying to your letter of the 4th inst., I take pleasure in recalling a few of the incidents occurring during the years 1898 to 1901 at the old "School."

One cannot think of the old days at the School without thinking of the man responsible for its very existence. Dean Galbraith, known by all as

"Johnny," was the friend of every man there, and when I look back at the various "trials" held in his office in an endeavor to find out which year committed certain outrages (?) I cannot help but remember the little twinkle which used to be in his eye as the evidence was extracted. I think Johnny took about as much pleasure out of those "trials" as we did.

C. H. C. used to be looked on as a pretty fair photographer in those days and Johnny used to send C. H. C. out with the camera to get a photograph of the ringleaders in many of the scraps. Of course, I don't suggest that C. H. C. intentionally spoiled the plates, but such photos were usually out of focus or spoiled in some other way.

Once we stole the cannon from in front of the Military Institute and took it up to the School. Meds soon found out about this and after many battles they captured it. That old cannon frequently passed from Meds to School and back again, and the last I remember of it was that it had been dropped down between two of the Med buildings. Oh yes, we sure did shoot it off and broke lots of windows too.

There is one incident I can never forget. Prof. Duff, also called "Johnny," was lecturing to us in some third-year subject. There was a scrap going on outside between School and Meds. About half way through the lecture Johnny Duff walked over to the window and looked out. We could see him smile. Then, without turning from the window, he drawled out in the lowest tones, "Gentlemen, I think the School is getting the worst of the scrap." Exit 3rd year en masse!

There were an awful number of liars at the School in those days. When Doc. Ellis would endeavor to show us some complicated calculation in chemistry and would say "seven and three are sixteen and this added to eleven is nine" and would then turn to the class and say, "Is that right?" every man there would say "Yes, Sir."

Of course, we had tapping and painting in those days. We practised on our own men and then showed Meds how it was done. We seldom had a scrap with Arts, although they outnumbered School many times.

Speaking of painting, I remember when the stone steps leading to the main entrance of the Red School were painted. The top step was yelllow, the next blue and the next white and so on for all the steps. I forget what the fine was, but there were two men removing paint from those steps for many days.

Taking a hurdy-gurdy through the halls of the School and then into the lecture room was tame in comparison with the time that we took a full-fledged Highlander playing the pipes into one of the galleries at the Parliament Buildings while the House was in session. Why this was done I cannot remember, but I suppose there was a reason (?) There was always a reason for everything we did in those days.

At the time of the South African War, we always had a parade down town when good news arrived. I remember when Kruger was captured, we got a Grand Trunk lorry and mounted a large cage on this. A rather quiet fellow in the first year was "selected" to act as Kruger and he was put in the cage and the cage tied down. He wore a beard and really looked like the pictures of Kruger. The placard on the cage stated that this was really Kruger. All went well until we reached Queen and York Streets and then a mob of kids plentifully supplied with choice rotten eggs serenaded Mr. Kruger. The cage was open on four sides and poor Kruger could not get out.

Hallowe'en night was the big night. Theatre first and then quietly disperse to meet again somewhere above College Street. Of course the police would be on hand in swarms and just as soon as we attempted anything they would charge us. Then we would disperse and meet again at one of the Ladies' Colleges. Once in a while a man would be captured by the police but usually the police were contented if they could wallop a few of the boys on the head with their batons.

We were serious in those days too. I remember we had every newspaper in Ontario publish an article stating that a new Mining Building was necessary at the University. We had letters written to every M.P.P. and many of them were seen personally. We had resolutions passed by the Manufacturers' Association and the Board of Trade stating that such a building was required. All the newspaper clippings were pasted on a roll of paper about 12 inches wide and "miles" long. An appointment was made to meet the Cabinet and our best speakers were selected. The climax came when the roll was dramatically unrolled before the members of the Cabinet and the opinion of the Press was presented in compact form. The new building now stands at the head of McCaul Street.

There were no year yells in those days. Last year the years '98, '99, '00, '01 and '02 organized and called themselves the "Century Group." Watch us at the next Annual Dinner and you will admit that while we are all getting older (not old) we still have lots of the old School pep left.

Five o'clock, Gentlemen.

Yours sincerely,

F. W. THOROLD.

## And now:

"Five o'clock, gentlemen!"

The lecture is over. The picture of the "Old School" has been drawn to a close. From the dim past, where we have been wandering through the childhood days of our "little Red School house," through exciting police encounters and Literary Society elections,, through time-honoured Med. scraps and theatre nights, we reluctantly drift back to 1923. But in our return we have brought with us a new interest and affection. We'll make it a point of having another look at those engraved letters over the northern entrance. Let's stroll around to the old Y.M.C.A. building and make a closer scrutiny of its weather-worn structure. Those old pictures of austere-looking gentlemen, past which we've hurried for that nine o'clock lecture, mean a little more to us now that we've had a look into the bygones.

So we have seen the birth of this School Spirit; we have followed its infancy through the pioneer days when it grew in leaps and bounds due to the necessity of its existence, and now it has reached, in our time, its height of youth. Let us hope that it remains in this youthful stage, may it never grow old, but be a constant source of memory re-awakening for our graduated predecessors who knew it in its childhood, and a constant source of incentive for we who are about to depart from its portals.

We would like to take this opportunity of expressing our sincere feeling of gratitude to these men who so generously contributed articles for this "Old School Reunion." It has brought us closer to them and as we followed them through the memorable past, a closer "tie that binds" has come into existence. The success of this department of the Year Book has rested entirely in the hands of these graduates and the way in which they have responded has shown us that their love and loyalty to our Alma Mater is undying.

This "Old School Reunion" has been a new departure for "Transactions," having its first appearance in last year's issue. The idea was an excellent one and has brought a new interest in this publication, not only for students, who have acquired a new slant on "School's" life, but for those graduates who were present in the foregoing events, this book will awaken old experiences and acquaintances. So may we take this opportunity of congratulating the originators of the idea and of expressing the hope that it will remain as a permanent department of "Transactions."

# A
# Message of 1923

This is a year of Service. This is a message for the readers of Engineering Society Transactions in this year of Service. Service is needed now just as much as it was ten years or five years ago during the war.

The members of the Engineering Society who have produced this volume, and the undergraduate and graduate members who read it, are living and working in the midst of a period when Service is at a premium. Are you going to take advantage of it?

Yours is the advantage. You are prepared, you are, as young engineers, naturally the kind of persons for Service. It is to you that the State and the Country generally, will look for the nature and extent of Service that is needed for these next few decades in the development of this great Dominion of Canada.

You will spread over the Dominion, over the Empire and over the World. The preparation you have had in this University and the experience you have gained by playing your part in the work of the Engineering Society and in the publication of these Transactions will stand you in good stead wherever you may be and with whomever you may be in contact.

Play the game of Service; it is worth while. It is worth while to the Country, to the profession, to your comrades and to yourselves. May I again ask you to remember the old saying that he who would be great among you must first serve.

My best wishes go to you whether you are graduating or remaining for other years, whether you stay near home or spread to the farthest parts of the Continent. I will expect you all to be serving and subsequently leading wherever you are.

(Sgd.) C. H. MITCHELL,

*Dean.*

# Transactions and Year Book

*of the*

# University of Toronto Engineering Society

With which is incorporated "Applied Science"
PUBLISHED ANNUALLY BY THE SOCIETY

No. 36 TORONTO, APRIL 15th 1923

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# *Editorial*

With this issue the "Transactions of the Engineering Society" completes the thirty-sixth cycle of its existence and the third since its rejuvenation. The history of the publication is practically a history of the School of Science. It is the Society's official record of accomplishment and is, as such, submitted to alumni and undergraduates.

In collecting material for this volume certain papers have been included which were not actually delivered before the Society but the aim has been to strike a medium between the ultra-technical paper and the general article, yet to have each justify its place in an engineering publication. The Year Book, the account of what Schoolmen have done in the past Session, is a record of real achievement in which everyone has had a part and upon which all may look with true pride.

Attention is directed to the section dealing with the "Old School" for it is upon this foundation that we of the present day and generation must build, and with which we should all be familiar. Only by looking backward upon the traditions handed down by those who trod the path before, may true School Spirit be builded with which to face the future.

And so "Transactions, 1923" goes out. For its shortcomings the fault is our own, and for any merit it may have credit is due to those members of the Engineering Society who have made it possible.

TRANSACTIONS
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J. F. Pedder (Associate Editor).

INSET:—

C. A. G. Wade, (Associate Editor.)

## *The Society—and Its Members*

On reviewing the past four years from the standpoint of an undergraduate, one is struck with the versatility of the men of School. In the field of sport and the field of learning the men of this faculty have acquitted themselves with great credit. From pink teas to debating platform, from gridiron to squash court, from a rough house to a formal dance, even from the sublime to the ridiculous, following one another with lightning-like rapidity, School men seem to be able to carry themselves with ease. Whether this be due to a chameleon-like character produced by necessity or to a combination of initiative and adaptability produced by environment and training, it is difficult to ascertain.

But one thing seems to be certain and that is, that in School life with its wide diversities of thought and action, the controlling factor in the make-up of character has been the influence of the Undergraduate body known to us as the Engineering Society. In its welding effect it should give a spirit of loyalty and unity as well as a sense of independence which should go far in years to come to produce true citizenship and all it involves— "Wad some power the giftie gie' us—" but apart from parchment and penwipers, the severing of relationships with School, and that which makes School —the Society—will come hard to all of us. And so it is with some slight courage backed by many happy memories that we of this year's graduating class set forth into life to do, to dare, and to achieve, what, we know not yet.

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## *Pat Lyle—An Appreciation*

School spirit—education—executive and athletic activities. To take an intelligent interest in one and all and to balance properly the pendulum between labs and lectures on the one side and sport and "joy-jobs" on the other has been the problem of many a good School man before this.

Pat Lyle has run the gamut of University experience during this past year. Besides being President of the most unified and outstanding body of undergraduates in the U. of T. he has managed to take an extremely active interest in the affairs of the S. A. C., the Board of Stewards and the House Committee of Hart House. At no time resting on his laurels but ever ready with advice and assistance, Pat has achieved successes the nature of which are granted to few to obtain.

His regime has been one of innovations. In handling the initiation question, establishing School Night on a sound basis, breaking the ice with the employment situation and above all in centralizing the activities of School in the Engineering Society, he has had complete success. At the same time he has handled School's affairs impartially and with a loyalty that is hard to resist and has been responsible to a large degree with the extraordinary efficiency with which matters pertaining to School and Schoolmen have been carried out during the session 1922-1923.

Irish, with the traditional eloquence, earnest and sincere in all things, those of us who have worked for and with Pat have realized what a pleasure it has been to share in his whole-hearted and unselfish endeavours in the interests of his fellow undergraduates.

And so at this time of graduation all School joins with us in saying —Au revoir, Pat, may success and happiness be yours wherever you may go and whatever you may do.

# SOME'AT ABOUT THE ALUMNI

The Engineering Alumni Association came into being as the result of the 1919 Reunion that gathered in many of the men who had been for several years active in the various local associations that existed in the larger centres.

Why an Association? It is generally appreciated that there existed among School men a "camaraderie" and good fellowship that is developed to a degree more marked than is general in large transient groups of men. Undoubtedly and very evidently this spirit of bonne entente is the result of a common regard for some thing that, for lack of other descriptive phrase, we call the Old Red School. This does not mean the red brick building and frankly does not mean the staff, nor the so often maligned courses of instruction nor only the sports and episodes that go to make up the happy memories of college days, but it is the "tout ensemble" of these things that may be known as Alma Mater. And Alma Mater commands a regard from School men for all the years after they pass out from her portals. The big family likes, as families do, to hang together and keep in touch, and an association of Alumni was deemed advisable to foster this desire to get together and stick together and to help, where possible, our Faculty, our University and our fellows in the profession. The Association was formed, it has flourished, and with the natural growth of two or three hundred a year that each new graduating class is bound to give, it should grow into a strong active organization.

Opinion is divided in regard to the possible work of the Association, some of its members holding that it cannot be more than a social affair designed to hold together School men and to foster School spirit. Others believe that it can be an active factor in engineering education at Toronto; that in time it may lend valuable counsel and aid to the Faculty and University and in future years may lend some financial assistance to special projects, and many members of this mind feel that the Association cannot continue to live unless it can accomplish some useful purpose.

The work the Association has interested itself in to date includes both phases. It has organized and pulled off Annual Reunion and it has interested itself in and offered counsel and assistance in government investigation of University affairs, in the projection of new and needed courses, in the employment of undergraduates and in many incidental affairs of graduate and undergraduate interest.

The future of the Engineering Alumni Association is bright and it welcomes the advent of the Graduating Class of 1923—hopes that this class will add another strong and interesting group to the Association.

C. E. MACDONALD,'18.

# THE ENGINEERING SOCIETY ANNUAL DINNER

Transcending all previous affairs the 33rd Annual Banquet of the Engineering Society in the Great Hall at Hart House has left a memory not soon to be eradicated in the minds of all those who were present on Wednesday evening, Nov. 15, 1922. Food unexcelled, music par excellence, beautiful decorations, witty and interesting speakers, toasts, boxing bouts and burlesques all contributed to make a perfect evening.

Dean Mitchell started the ball rolling by saying grace. When all were seated the famous School quartette beautifully rendered some folk songs. Song sheets containing the latest "hits" were passed around and the hall was filled with the music of nearly a thousand voices. The interval between the first and second course was occupied by the charming rendition of that beautiful lullaby, "Sleep Kentucky Babe," by the quartette.

The first toast was to the King. The President of the Society, in his opening speech said that his remarks should be brief, and illustrating his point likened his remarks to ladies' skirts, they should be short enough to be interesting and long enough to cover the subject.

R. G. Morrison, of the graduating class, proposed the toast to the University, and the President of the Society introducing Dean DeLury, who was to respond to the toast, in view of the absence of President Falconer, reminded him that everything approached a limit. In responding to the toast Dean DeLury proposed that the members drink to the President.

While passing through the Rocky Mountains Dr. Coleman's train stopped for a short time, allowing him and some of his fellow passengers to take in the view, and they were greeted with a welcome "Toike Oike" coming from somewhere among the rocks. In his travels he has come upon graduates of School in every quarter of the globe and further, he went on to say that should he ever go on a geological survey to the Antarctic regions he would expect to hear the same irresistible "Toike Oike."

In proposing the toast to the Faculty, Mr. J. M. Dymond showed that the outstanding feature of S. P. S. was that it had spread. In looking a long way forward to the 50th anniversary he suggested that it should take the form of a huge reunion with exhibitions and theatres showing what S. P. S. had accomplished in the past. These, he said, would act as a great inspiration for the future.

Replying to the toast of the Faculty, Dean Mitchell made some amusing references to the menu card of the 11th anniversary, stating that he was a freshman at the first dinner. He then went on over the old days when Dean Galbraith and Dean Ellis were living. He hoped their memory would ever be green. He gave as an example of our progress here in Canada the difference between the old "sewing-machine" engine he had seen at Port Hope in the early days and our huge modern locomotive. He spoke of the far greater opportunities we had to-day than those of thirty-three years ago. "We are just starting in Applied Science," said the Dean, and he went on mentioning the myriad problems that to-day are still unsolved. Among others were: the national railways problem, good roads, the long distance transmission of electric power, heating, development of oil in the West, and the Radio problem, which are still in their infancy.

Mr. MacQueen gave a solo.

The toast to the profession was proposed by A. M. Reid '23. He spoke of the necessity of raising the status of the profession by law, saying that engineering was dynamic, not static, and he deplored the lack of representatives in legislative and arbitration boards.

As Professor T. R. Loudon rose to reply to this toast he was greeted by clapping of hands and many an approving voice. He stated that the registration of engineers was a stepping stone to further legislation and he showed that "the demand for technically trained men is unlimited" and that there was no fear of engineers being a drug on the market.

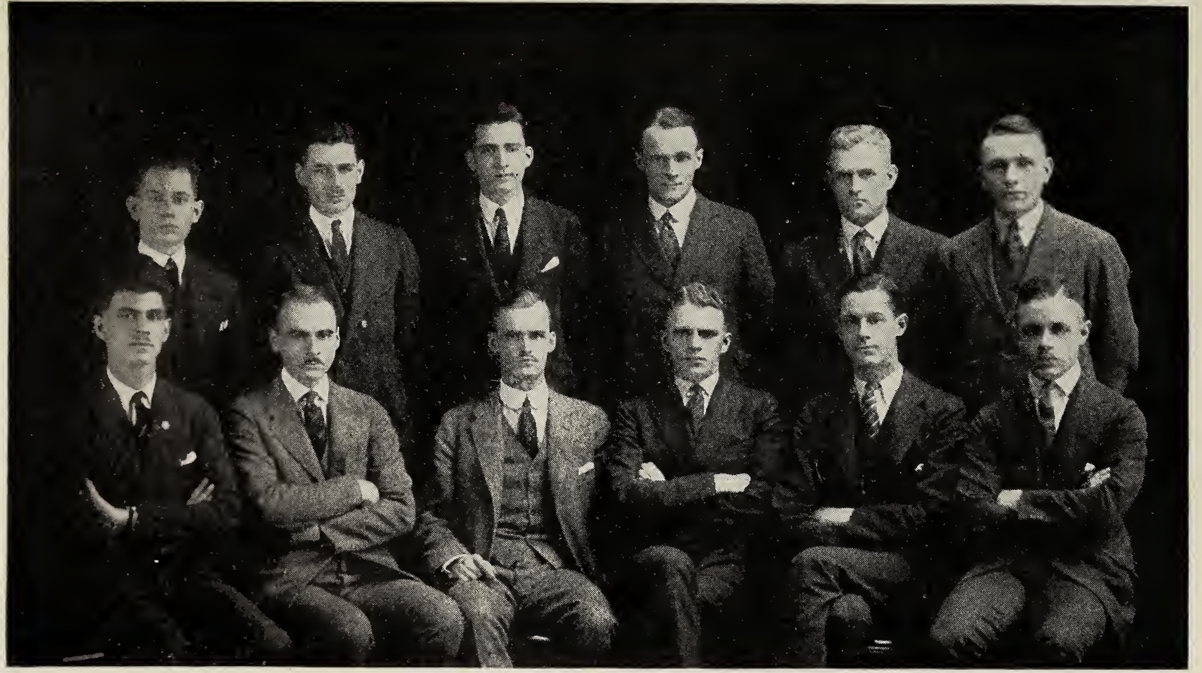
A toast to the Sister Societies was proposed by H. E. Morris of 2T3, saying that we were all engineers. He wished every prosperity to the societies.

Mr. Dingman of R.M.C. replied, representing R.M.C., McGill and Queen's, in a very smart and attractive fashion vaguely reminiscent of the army.

In an absorbing three-round boxing bout, Maguire vs. Seaborn, drew even.

Mr. Grace, an entertainer, gave some very amusing impersonations. Then followed the hit of the evening when a burlesque bout was fought between "Chatson Hamilton Wright" and Jerusalem Rebekka Cockburn; at the end of three rounds it was a draw. But on overtime Chatson defeated Rebekka by poking him one in the jaw, laying him out for a count. The President of the Society then declared the banquet over and the members dispersed carrying with them a greater love for the Old Red School.

C. A. NORRIS.



S.P.S. DINNER COMMITTEE.

TOP ROW:—F. J. Wallace, C. F. Cockshutt, E. G. Davies, C.B. Macqueen, C. M. Boyer, N. E. McPherson.
BOTTOM ROW:—C A. G. Wade, T. W. Jackson, C. A. Norris (Chairman); F. J. Lyle, V. D'e. Strickland. W. D. Jewett.

# THE ENGINEERING SOCIETY ANNUAL AT HOME

"On with the dance," said the School men on Wednesday night, January 17, and on with it they went. The unparalleled success of the Annual At-Home of the Engineering Society makes it stand out as a social event which beggars description. Each man who had been lucky enough to obtain one of the 350 tickets available appeared resplendent in evening dress; he may have forgotten his programs, or his ticket, but one thing he did not forget and that was to be there and to have "her" with him. And Oh what a sight it was! Did some one remark that the School man was backward in social affairs? Let him read these words and forever hide his face.

Promptly at nine o'clock the expectant couples were received by the patronesses, Mrs. C. H. Mitchell, Mrs. C. H. C. Wright, Mrs. P. Gillespie, Mrs. H. E. T. Haultain, Mrs. J. W. Bain and Mrs. T. R. Loudon, while Mr. Todd bade his band of associated worry banishers and jazz syncopaters to commence their feats of musical excellence.

As if by a miracle the sumptuous Crystal Ball Room of the King Edward was filled with a multitude of joyous dancers. Bumps were exchanged with the greatest of good nature, for though the ball room was large so also was the crowd. And the moon waltzes were enjoyed to the nth decimal place. The freshman who had never been at an event of this kind ceased to worry whether his ready-made tie was on straight and entered into the spirit of the dance. And some there were who, perhaps a little wearied, sought quietness far from the eyes of patronesses in the secluded spots specially provided for "sitters-out" and for which the Eddie is famous. And as if to throw more light on the situation the spotlight singled out would-be Vernon Castles—now one and now the other, with its multicolored beams producing over the whole hall a Kaleidoscopic effect intriguing in its splendor.

Then too there were the butterflies, not real ones but ethereal creations which floated along the walls in a never-ending line. How they were induced to be present is a mystery but that they were beautiful is a fact and that they were there is also true.

In the first half of the evening a diversion was provided by Miss Le Barnes and Mr. Mosher, Jr., who offered a special exhibition of dancing in a most pleasing manner. Their interpretation of the latest ball room dance, "The Bandolero," was particularly well executed and was applauded heartily.

After lunch many innovations were introduced and perhaps the most unique of these was the "Doll Dance." For this absolutely new and orig-

S.P.S. DANCE COMMITTEE.

TOP ROW:—H. E. Stewart. L. F. Stokes. H. N. Baker, G. A. Murphy, J. W. Pearson.
BOTTOM ROW:—W. E. Carswell, H. J. Coulter, C. A. Norris (Chairman); F. J. Lyle, A. M. Johnson, C. T. Sharpe.

inal feature some 25 dolls were "broadcasted" amongst the dancers. These were to be passed from one to the other and when the music stopped the couples holding the dolls were to retire from the dance, passing on the dolls to others. By this elimination process finally 25 couples would be left on the floor and they would be the winners of the dolls. The introduction of this dance brought about great excitement and though not following out to the letter the rules of the dance it was obviously a huge success.

A most delightful feature of this part of the dance was the impromptu dance specially given by Mr. R. B. Kerr and his partner. These young people showed real talent in this line and their dancing was highly appreciated.

All too soon came the hour for departure, but promptly on time the last dance was played and the gay dancers regretfully, though with the knowledge that "all things must end," betook themselves towards the check room and thence homewards.

C. A. NORRIS.

# SCHOOL NIGHT AT HART HOUSE

School Men, otherwise known as members of the Engineering Society, made a distinct name for themselves in the past term by virtue of the fact that they staged the first attempted innovation of its kind—"School Night at Hart House." For the benefit of all and sundry who were not fortunate enough to attend this unique function, a little explanation of the same might not be amiss.

First, for the reason. As is pretty generally known, the halls of Hart House are above all else open only to men students. When members of the weaker sex—to use a much hackneyed if doubtful phrase—do obtain admission within the sacred portals, it is to attend some one social function, a dance or perhaps a recital. As a result they see Hart House only as a Dance Hall or a Concert Hall. Besides, of course, on specified Sundays, the proud student may show lady friends through the house. "We can swim here," says he, as they pass the tank—or "We read here," as they pass the library. "It must be *wonderful*," says his fair partner, but since in practically none of the parts of the building are any activities in progress, said fair partner rarely appreciates the real possibilities of Hart House.

"This must not be," said the School Men. "We will devise a plan whereby our lady friends may view Hart House 'as is.' They must see all the departments in action—even from the rifle ranges to the library."

Pat Lyle, assisted by his Engineering Society executive, as well as by many other willing souls, racked his brains for weeks to devise a plan with a result which was startling, successful, and unique.

"The Shriek"

January 29 was the night set for the glorious event and 7.30 was the zero hour. Every School Man received admission free, and besides this a considerable number of graduates and friends of the School Men were the happy recipients of the precious pasteboards without which it was futile to enter the building that night. The total attendance was about 2,000, or 1,000 couples—need it be said that Hart House had the appearance of being very much alive?

As was the intention, all departments of the House were "wide open." As a result of laborious efforts, three performances of a notorious play called "The Shriek" were given in the Theatre by an all star cast. Digby Wyatt as the Shriek deserves special mention, while Teddy Huggins and Johnny Dumbrille, as the worthy surveyor and his assistant who attempted to rescue "Neuralgia," the distressed damsel, from the hands of the Shriek, played their part to a nicety. Needless to say that Ralph Kerr made a realistic "damsel" whose signs of distress were only too evident. Pete Culliton made a very affable announcer, giving some few necessary explanations at the beginning of each scene. The fact that the lions refused to eat the surveyor when so bidden, proved an insurmountable difficulty, however, which, in every case, precipitated the end of the performance. The Shriek was, however, appeased with a lollypop, and at the end of the last performance the lions were slain and given to the surveyor to eat, since their period of usefulness was over.

But to show Hart House in full swing was not enough. A noisy, enticing, and get-together midway was to be seen and heard along several of the corridors on the main floor. Here Prof. Humbug astonished thousands with his marvellous transformation trick — Pooki performed wondrous mind-reading feats, while Barney Google displayed Spark Plug to curious spectators.

Each department of the different years ran a side-show and the frenzied efforts of the contending barkers were rewarded by enthusiastic crowds who packed around the centres of interest, straining every muscle to win the coveted lollypop or box of chiclets.

Besides the Midway several important and more serious entertainments were in progress at different periods throughout the evening. There were swimming and water polo exhibitions in the tank, basketball games, fencing, boxing and wrestling matches in the gyms. and shooting competitions in the rifle ranges.

The Toike Orchestra provided an excellent programme in the Music Room, whilst Professor Benson gave an exhibition of billiards in the Billiard Room. In the Sketch Room, a fine selection of works by C. W. Jeffries formed the chief attraction.

Then, that none should feel the pangs of hunger, "Hot Dawgs" and Coffee were obtainable in the Great Hall at the nominal rate of 5c per item. The mustard for the dawgs was thrown in gratis. This small outlay—20c—for she was usually too excited to eat more than one, constituted the sole expense to the wary stude—a remarkable fact indeed.

At 10.30 dancing commenced simultaneously in the Great Hall and the Little and Big Gyms. Bill Turner's Orchestra provided the necessary syncopation in the Gyms., while Zet Frat's orchestra obliged in the Great Hall. This delightful part of the program capped the climax of a glorious evening and at one o'clock the School Man and his partner, sought their respective check rooms and thence journeyed home. Some were on time at the nine o'clock lecture the next morning and some weren't—but they all had a good time the night before. It is to be noted with great delight that School Night at Hart House now bids fair to be an unusual event. taking its place among our most popular celebration events.

J. F. PEDDER.

# INITIATIONS

A definite step towards the decision on the initiation problem was made on Friday, Feb. 9, 1923, when by an overwhelming majority a general meeting of the Engineering Society decided in favor of the present system of initiations at School with the sole recommendation that a committee be appointed from Sr. School to co-operate with the Sophomores and Freshmen to assure a smooth running ceremony. While several alternative methods of initiation were proposed, they found small favor and despite the fact that they were excellently presented by their advocates, met severe defeat.

Opening the meeting, F. J. Lyle, president of the Society, spoke of the general growth of opinion throughout the University that the time was ripe for a settlement of the vexatious initiation controversies. He stated that, while the S. A. C. would no doubt draw up a set of rules, as the result of the investigations then under foot, a strong feeling existed that School should battle out the problem for themselves.

Many and varied were the opinions expressed by members of the Society. A few favored a return to the old free-for-all scrap, while another was inclined toward a general University initiation, but no one advocated complete abolition. Some interesting viewpoints were given by members of the Junior Years on the purposes of initiation. The general feeling seemed to be that at the same time as putting the Frosh in his place he should be made to appreciate School and thus unite his year. This idea was enlarged upon together with the opinion that Sr. School should hold the controlling hand and give advice from out their past experience.

After a lively two-hour discussion the meeting placed itself on record by practically a unanimous vote in favor of the present system, leaving in the hands of the Engineering Society executive recommendations towards the mode of procedure in the future with regards to the supervision of Sr. School and the time and duration of the actual initiation and the ensuing social celebration.

W. S. Maguire
A. V. Price
W. S. Wingfield
A. S. Crawford
W. J. McClelland
L. M. Price
A. A. Bell
M. E. McQuarrie
C. A. Norris
F. J. Lyle
T. M. S. Kingston
J. W. Kennedy
UNIVERSITY of TORONTO ENGINEERING SOCIETY EXECUTIVE
G. A. V. Armour
P. S. White
W. R. Bodie

# ELECTIONS

School once again surpassed itself in its annual elections. From Wednesday, February 28, until the small hours succeeding the evening of Friday, March 2, all enjoyed themselves; even to the president of the Y. M. C. A., whose words were: "There never was such another night as Friday."

Nominations were held ex consuetudine in the first year drafting room in the roof of the Old Red School. 2T3 enlivened the proceedings by having one man for each position, even to that of Dean, causing much consternation amongst the members of the faculty and the other years. Thursday was spent in violent electioneering campaigns. Festivities opened on Friday with a meeting of 2T3 to listen to the libelous and abusive speeches of fourteen of their number who were running for vice-president of the permanent executive. Immediately after this meeting School gathered in the Great Hall of Hart House where luncheon was rendered exceedingly delightful by some of the various seekers after office with their witticisms. The bill of fare for the afternoon provided for voting and theatres. One theatre party considered themselves lucky in seeing two shows for the price of one. Evening found a huge congregation assembled in the drafting room behind Convocation Hall where, thanks partly to the efforts of the promising M.D.'s of the chemical department, a wild and woolly time was had by all. Numerous motlied games, unlisted in the annals of legitimate sport, were indulged in, punctuated by Pat Lyle and his lantern, broadcasting the results. The grand finale took the form of a real rip-roaring parade which successfully serenaded each and every one of the women's residences and incidentally captured the two iron lions from the front of the Forestry Building. These remained in the possession of School for several days, decorating the steps of the Mining Building.

The elections were appreciated by all good undergrads. of S. P. S. Pat Lyle and his executive, George Langford, and his morality squad were 100 per cent. efficient. All details went smoothly, so much so that parliamentary procedure might well copy.

# Engineering Society Election Results

| | |
|---|---|
| *President* | W. A. Osbourne |
| *First Vice-President* | W. E. Carswell |
| *Second Vice-President* | G. W. Smart |
| *Treasurer* | J. F. Millican |
| *Secretary* | K. Lally |
| *Curator* | R. Complin |

## Chairmen of Clubs

| | |
|---|---|
| *Civil Club* | W. H. Campbell |
| *Mining and Metallurgical Club* | Ken Gray |
| *Mechanical and Electrical Club* | H. J. Pugsley |
| *Chemical Club* | H. Baker |
| *Architectural Club* | E. M. Coleman |
| *Debating Club* | G. Rowat |

## Athletic Association

| | |
|---|---|
| *President* | R. Laurie |
| *Vice-President* | C. A. Morrison |
| *Secretary-Treasurer* | F. J. Milne |
| *Fourth Year Representative* | B. C. Matson |
| *Third Year Representative* | S. Perry |
| *Second Year Representative* | R. K. Innes |

## Year Executives

| | | |
|---|---|---|
| *Fourth Year* | | |
| | *President* | W. A. Becker |
| | *Vice-President* | G. Robertson |
| | *Secretary* | A. R. Colman |
| *Third Year* | | |
| | *President* | H. Smith |
| | *Vice-President* | W. J. Cameron |
| | *Secretary* | J. W. Pearson |
| *Second Year* | | |
| | *President* | D. W. Dow |
| | *Vice-President* | C. T. Nugent |
| | *Secretary* | F. W. Bruce |

## Y.M.C.A. Executive

| | |
|---|---|
| *President* | John Beattie |
| *Vice-President* | H. Papst |
| *Secretary* | H. B. Ruggle |

## 2T3 Permanent Executive

| | |
|---|---|
| *President* | A. M. Reid |
| *First Vice-President* | H. E. Wingfield |
| *Second Vice-President* | H. B. Morris |
| *Third Vice-President* | A. A. Bell |
| *Secretary* | C. A. Norris |

## School Representatives on the Hart House Committees

*House Committee*—J. M. Dymond, W. A. Osbourne, Frederick Wallis.

*Hall Committee*—H. S. Clark, C. S. Sneyd, C. R. Davis.

*Music Committee*—F. B. Boswell, H. A. Greenwood, D. S. Lloyd.

*Billiard Committee*—J. D. Burbank, V. A. McKillop, E. K. Mueller.

*Library Committee*—L. C. Jackson, K. R. Sommerville, J. A. Williamson.

# ENGINEERING SOCIETY WEEKLY DOLLAR DANCES

Just a few explanatory words with regard to the recent addition to the social life of School.

For some time there has been the feeling amongst School men of the lack of an inexpensive dance where they may meet under a common roof and be sure of a real social evening without the superstitious fear of too much formality.

When the Engineering Society finally decided to create the Weekly Dollar Dance they felt that they were taking a move in the right direction. In doing this they felt they would bring about a closer relationship amongst the students themselves and between members of the school and staff, and at the same time fill this great need.

Have you ever passed the remark that it is strange the number of men in your own year that you know to see but cannot call them by name? This is one thing we hope to overcome. Besides this, all the Professors have been extended an invitation and up to now several have accepted, and we hope that in the future we will be honoured by the presence of those who have been unable yet to attend.

I think I am safe in saying that it is the general impression that an undertaking of this sort is considered a money-making machine. However, any who have taken part in the production of a Year or School dance realized the fallacy of this idea, and realize, to say the least, that it requires great care to even keep such an enterprise on anything like a sound financial basis.

What our object is, is to give at cost to the students of this faculty, an evening of maximum entertainment, and as long as this is appreciated to the extent of an even balance in the books at the end of the year, the Society will feel these efforts were not in vain.

I might also add that there existed an understanding that this dance was exclusively a School affair. We would like to say that friends of School men are always welcome, as we feel sure that they will help us to keep this dance at its present high standard.

In future we intend adding novelties each Saturday evening, and by watching the ads around School, you can keep yourself posted.

Every Saturday evening you will find the Engineering Society at home at the Metropolitan Assembly Rooms, 247 College Street, between the hours of 8.30 and 12.00 o'clock. One dollar per couple, including tax. Tickets may be obtained at the Supply Department.

The above remarks appeared in Toike Oike in the issue of November 28th. When this appeared, the Engineering Society Weekly Dollar Dance was still in its infancy, and those in charge of this new venture were still labouring under the uncertainty of success. Now, however, that a year year has slipped by and we can consider this new idea from a viewpoint of results, there is only one conclusion, and that is "success."

In the first place, the financial statement was practically all that could be desired. Here, it must be remembered, that this venture was not inaugurated with the idea of turning it into a money-making machine. The policy, putting it short, was "Most for the least," and the three and one-third per cent. loss on the total expenditure of fourteen hundred dollars, is very satisfactory.

Secondly, the present popular demand for a repetition next year, shows that the popular Dollar Dance is filling that long felt want.

A very pleasing feature this year was the way the members of the staff accepted their invitations, and were seen on different Saturday evenings entering into the real spirit of the Dollar Dance.

In conclusion, we would like to say that the Engineering Society Weekly Dollar Dance, born to reality A. D. 1922, has been a real success, and we hope that it has become a permanent part of School life, as the results of this year show, if nothing else, that it is a large factor in uniting a "big and live Faculty."

R. M. LAURIE, Manager, Weekly Dollar Dance.

# THE TOIKE OIKE

For the benefit of those who are not acquainted with the past history of the Toike Oike, it may not be amiss to outline a little of it here.

Its first appearance was at the Elections in 1911, the idea originating with Mr. Stiles, '07. On this occasion it appeared on each of the three days preceding election day and contained policies and platforms, the last issue containing photographs of the presidential candidates as well. For the next several years it continued to appear at election time and was considered a very important part of them. During the war, however, it disappeared and was almost forgotten. Then, in 1920-21, Mr. Downie brought it once more into the light of day, making it the official organ of the Society, to appear monthly or at the discretion of the Society. As such it has continued to flourish.

This year Toike Oike has made six appearances. The first issue was in September and was intended principally for the benefit of the Freshmen. The second issue, in October, came out the day before the "Old Boys' Reunion," and formed an integral part of the Society's official welcome. It contained the official program of the Reunion, definite information about each event in the program as well as "School" news which was thought would be of interest to the "Old Boys." The next two issues, in November and January, were perhaps of more particular interest to the student body. The last two issues appeared during election week and were devoted to election propaganda. The first five issues consisted of four pages, but the last one was increased to six because of the unprecedented demand for space by the enthusiastic candidates.

The aim of the Toike Oike has been to be of greatest service and interest to the student in every way. The various clubs were able to keep their members enlightened as to their activities, present and future, as were also the several years. Every effort was made to keep the Schoolmen acquainted with the numerous branches of sport of School as well as the exact position School held in them. No less effort was expended to keep the spotlight on all social activities both Faculty and Year. In each of these departments the activities were very great and it was only by co-operating with the executives of them that we were enabled to do this. It may have been noticed that the Toike Oike did not print technical papers and treatises. That work has been reserved for Transactions, in order that Toike Oike might remain as a newspaper.

In conclusion, the Toike Oike would like to thank all those who contributed to it at any time and thus helped to fulfill its purpose of service to the student body.

W. R. Chowen, Editor Toike Oike.

# THE MECHANICAL AND ELECTRICAL CLUB

The Mechanical and Electrical Club during the School year 1922-23 underwent a marked rejuvenation. On returning for the fall term it was keenly felt that some reorganization was necessary, and the matter was quickly investigated. Public sentiment was tested and at a general meeting early in October three plans were submitted to the members for discussion. The first was to split the club into two groups, corresponding to the two departments. The second was to remain as before, and the third was to enlarge the executive by having a vice-president from both departments from fourth year and two representatives from the third year—one being secretary-treasurer—as well as the president, and the second and first year reps. After much discussion the last plan was finally agreed upon by the meeting. The results have since shown the wisdom of adopting this plan.

The first outing of the Club was a trip to Queenston to look over the Chippawa plant of the Hydro. The party, consisting mostly of fourth year men and accompanied by Prof. Angus, to whom the success of the trip was due, and Prof. Price, left Toronto early in the morning on the Cayuga and enjoyed a splendid trip across the lake. The students were cordially received by the Hydro men, who piloted them through the magnificent power house, which proved a revelation to most of the visitors.

E. & M. CLUB.

TOP ROW: H. J. Pugsley (III Rep.); H. P. Ruggles (I Rep.); R. E. Taylor (II Rep.).

BOTTOM ROW:—J. E. Goldie (Vice-President); W. A. Becker (Secretary-Treasurer); Prof. R. A. Angus (Honorary President); H. E. Wingfield (President); J. G. Inglis (Vice-President).

After a truly profitable visit, the party left Queenston in the evening and enjoyed a real old sing-song and smoker on the way home. This was greatly enlivened by the School jazz orchestra.

The second event was a lecture by Mr. Milne, of the City Works Department, on "Waterworks." The importance of the subject was appreciated by all and the speaker had a splendid reception. To make the descriptions given in the lecture clearer, the hydraulic option of the fourth year paid visits to the pumping stations in the city and saw conditions as they existed in a modern waterworks system.

Several city plants were visited by the other years and were voted extremely interesting and of great help in showing the practical application of the theories learned in the lectures.

The big social event of the season for the Club materialized when a dinner-smoker was held at the Walker House. This was attended by almost two hundred members and was voted a great success. The assembly was honored by the presence of Dean Mitchell and Profs. Price and Angus. The speakers of the evening were Rev. R. E. Knowles, the well-known author, who gave an elevating address on the value of public speaking, and Mr. Wills MacLachlan, the first president of the Club and now with the Hydro.

The spring term was enlivened by a skating party on Jan. 26th, and on Feb. 3rd a dance was held at the Metropolitan Assembly Hall. The following week a highly successful smoker was held at Hart House. Movies and musical entertainment were provided as well as eats and smokes and everyone had a real good time.

Probably the biggest venture of the year was a trip to Hamilton on Feb. 20th to visit four large industrial plants. A special train was chartered and left Toronto at eight a.m., with over two hundred men who, on arriving at Hamilton, divided into two parties and visited The Steel Co. of Canada, the International Harvester Co., The Canadian Westinghouse and the John Bertram plant of Dundas. The evening was spent at the Arena, where the Varsity senior hockey team were cheered and supported as they battled against the well-known Tigers, and the special left Hamilton at 11.30 p.m. with a tired but happy crowd.

The final technical meeting was held in C22 on Mar. 1st, when the Bell Telephone Co. gave a demonstration. The meeting was attended by over three hundred men and was voted as being one of the best of its kind ever held in School. On Mar. 8th the final meeting of the year was held when the new president was installed in office and the affairs of the year completed.

Besides these functions, much work was accomplished that will have a lasting benefit to the faculty. An employment bureau was fostered and final arrangements were placed in the hands of Sir Robert Falconer, Other student matters were investigated, such as the difficulties surrounding vacation work. Progress was made along these lines toward closer co-operation between Council and students.

The manner in which the members co-operated with the executive was very gratifying. These men saw a real place in School organizations for the Club and sought to realize their ideas. They felt the Club to be the essential link between the theoretical work and industrial practice and every Club member seemed to be imbued with the spirit generated by that realization. A great deal was accomplished this year, but much more can be successfully carried out in the future, but it will call for the closest co-operation between the executive and the members. With this co-operation there is no doubt that the Club will attain and maintain its rightful position as the best Club in School.

H. E. WINGFIELD, President.

# THE INDUSTRIAL CHEMICAL CLUB

Some of our neighbors, to wit, the professors in the Arts faculty, bemoan the fact that the student of to-day is not over-studious. (Of course, nothing is so good as in "the good old days"). It is hoped that this terrible allegation is untrue, but the fact remains that the student in chemical engineering is not interested in technical lectures in the evening. Probably after being exposed to technical and other kinds of knowledge from ten minutes after nine until five o'clock, the poor, would-be engineer craves recreation at night. Recognizing this fact, the executive of the Chemical Club inveigled the members into coming out to fewer smokers this year and with the guarantee that not even the simplest of chemical formulae would be inflicted upon them. As a result, greater numbers turned out at the meetings.

The executive for the year was as follows: Hon. Pres., Prof. J. W. Bain; Hon. Vice-Pres., Dr. M. C. Boswell; Pres., L. M. Price; Vice-Pres., H. N. Baker; Sec.-Treas., D. A. S. Lee; Curator, R. Hayward; Year Reps., IV. H. F. Robertson, III. A. F. Stuart, II. A. Harrop, I. R. K. Innes.

The year was commenced in the customary way with a dinner at the Walker House with seventy-five present. The speaker of the evening was Mr. Beynon, plant superintendent of the Dunlop Tire & Rubber Company. Mr. Beynon gave an interesting talk on rubber.

INDUSTRIAL CHEMICAL CLUB

TOP ROW:—R. E. G. Hayward (Curator); H. F. Robertson (IV Year Rep.); A. F. Stewart (III Year Rep.); R. K. Innes (I Year Rep.); R. C. Harrop (II. Year Rep.).

BOTTOM ROW:—H. N. Baker (Vice-President; Prof. J. W. Bain (Honorary President); L. M. Price (Chairman); Prof. M. C. Boswell (Honorary Vice-President); D. A. S. Lee, (Secretary-Treasurer).

The first smoker was held in C 22 on November twentieth. Moving pictures of Canadian chemical and metallurgical processes were shown, some of which were: "The Story of Paper," "Cane Sugar Manufacture," "Pig Iron and its By-products" and "The Refining of Nickel." During intermissions the musical and story-telling members of the club entertained. A lunch was served at the end of the evening, which was so complete that, it is said, even the freshmen had sufficient.

On the first Saturday morning in December, Dr. Redman spoke to the club. Dr. Redman, the inventor of Redmanol and now general manager of the Bakelite Corporation, talked on the shortcomings of the young graduate and impressed his listeners with his frank remarks.

Owing to a fifty per cent. cut in the membership fee, the club's coffers have not been so well filled as before. On this account, the Chemical Club dance, which has always been one of the events of the social season, but a financial failure, was not held this year. The Chemical Club took over the dollar dance from the Engineering Society shortly after Christmas and all members interested in the terpsichorean art turned out in full force.

The second smoker was held February twenty-second in Hart House. Again motion pictures of industrial processes were shown. At this smoker the music provided was unusually good. Besides the usual numbers from the musical members of the club, N. S. Grant sang, Fred Scott of the M. & E. Club appeared with his banjo and five members of the Stringed Instrument Club entertained very generously. The meeting finished with a lunch in the great hall.

Twice during the School year the fourth year men have been the guests of the Toronto branch of the Society of Chemical Industry at dinner, and for the meeting afterwards. It was through the kindness of Mr. Shoreman, of the British American Oil Company, and Mr. Neighorn, of the Nichols Chemical Company, that the fourth year Chemicals were invited to these dinners. The first was of the chicken variety and proved very delectable. The second dinner was fun at the time, but if the culprit is ever found who put the cathartic in the apple pie, his death will be a slow and a painful one. Dr. Ralph McKee, the head of the department of chemical engineering at Columbia University, spoke after the first dinner. His subject was "Gasoline Twenty Years Hence," and this illustrated lecture on the oil shale industry was very interesting. The second meeting was addressed by Mr. Francis M. Turner, Jr., of the Chemical Catalogue Company, of New York. His subject was "Chemical Plant Equipment." This lecture was the first of a series of six which were well attended.

With the permission of the author, Herb. McManus, and with the assistance of George Langford, of the Miners, the Chemicals are reproducing the "Shriek" for a smoker of the Society of Chemical Industry on March eighth.

The Industrial Chemical Club is finishing the year's activities with a dinner at the Walker House on March sixteenth, at which it is hoped K. S. Maclachlan will speak. As this will be the last meeting of the year, the club will then be turned over to its new chairman, Mr. H. N. Baker.

LLOYD M. PRICE, Chairman.

# THE CIVIL CLUB

The year is drawing to a close, because at this writing we are in the midst of the "School" election campaigns. This is a time for the changes in office, and the shifting of responsibilities. This is also a sure sign of Spring and that the day of reckoning is not far off.

The Civil Club have had a very successful year, and it may be well to give here a resume of their activities since last Fall. The Executive have endeavoured to have some form of gathering at least once a month.

The first meeting of the Club took place in Hart House on the evening of November first. The meeting, which was in the form of a smoker, was preceded by a game of indoor baseball between Civils '23 and '24. Professor Treadgold made an excellent umpire and the game resulted in a victory, to the tune of thirteen to seven, in favour of 2T3. It is rumoured that the 2T4 men should have practised the game harder at Gull Lake instead of being lured away from camp by the night life of Minden. After the game the party adjourned to the East Common Room where Professor Young, who was the guest of the evening, gave a very interesting talk. A Hawaiian orchestra was in attendance and rendered some very fine selections. This was followed by the good old "School" and Gull Lake songs, while the "eats" concluded the programme. About eighty members turned out to this event and a good time was had by all.

The next meeting of the Club was held on the afternoon of November twenty-second, when Mr. Norman MacLeod, president of the MacLeod Construction Company, gave an exceedingly interesting lecture on the "Construction of the Sixteen Mile Creek Bridge." The lecture was illustrated by motion pictures showing every phase of the erection. The interesting point in the construction of this bridge was that the spans used were from an old railway bridge in Eastern Canada. After the piers had been erected the spans were slid into position by means of an overhead cableway. The bridge was about one thousand feet in span and one hundred and twenty-five feet in height. A lively discussion followed Mr. MacLeod's lecture and many instructive details were brought to light. To conclude the programme, two films on Highway Construction were shown. This meeting was largely attended and a good number of students from other departments took advantage of this instructive lecture.

CIVIL CLUB

TOP ROW:—E. C. Shurly (Secretary-Treasurer); F. B. Boswell ('Varsity Rep.); A. F. Hunter (I. Rep.); A. R. Chadwick (III Rep.).

BOTTOM ROW:—W. R. Boake (II. Rep.); W. J. McLelland (President); Prof. C. R. Young (Honorary President); W. H. Campbell (Vice-President); H. G. Clappison (IV. Rep.)

On the afternoon of December the seventh the Club took a trip to Leaside to view the new Durant Motor Company's plant then in the course of construction. Professor Young and the resident engineer were kept busy answering the hundred and one questions of the would-be engineers. The buildings are constructed of reinforced concrete, and cover considerable space. One of the interesting features was the unique and ingenious contracting plant for chuting concrete. Practically all of the concrete on this job was placed by means of a tower and chutes from a central point among the buildings.

By way of a social evening the Club took charge of the Dollar Dance on Saturday evening, December the ninth. The tickets were distributed to Civils only, and as they were limited to one hundred the Club soon disposed of them. Everybody enjoyed themselves and voted it a large evening for a dollar.

Last, but not least, came the famous School Night at Hart House. Here again the Civil Club asserted itself and by way of our contribution to the night's entertainment a photographer's booth was rigged up. The true value of the time spent in the photo laboratory was found on this occasion. Hundreds of photographs of the budding engineers and their sweethearts were taken on this night. The Executive hoped to be able to award a prize to the most beautiful couple. However, after many meetings and much heated discussion we concluded that owing to the great number of handsome School men it would be impossible to award an individual prize to any one couple.

In closing, I would like to thank the Executive for their excellent work, the members for their hearty co-operation and support. At this writing the results of the election are not known, but in any event I know that if any one of the candidates receives the customary whole-hearted support another successful year for the Civil Club is assured.

W. J. McLELLAND, Chairman.

# THE MINING AND METALLURGICAL CLUB

As the School year draws to a close we pause to chronicle the activities of the M. and M. Club in another chapter of its history.

The opening of the fall term brought together miners and metallurgists who during the previous summer had ranged over most of Canada and part of the States in search of experience for the future and a financial backing for more immediate use.

The first general reunion of the men took place at a smoker in Hart House in October. Here a fund of interesting information was mingled with humor as the embryo engineers told of their experiences—and lack of experience—in the mines and smelters and on geological surveys. Professor Ellis concluded the addresses by a description of smelter operations in Wales. At this meeting the freshmen were introduced individually to the Club. After proving that they had the moral, mental and vocal qualifications for membership, they were admitted and allowed to sing the Club Chorus.

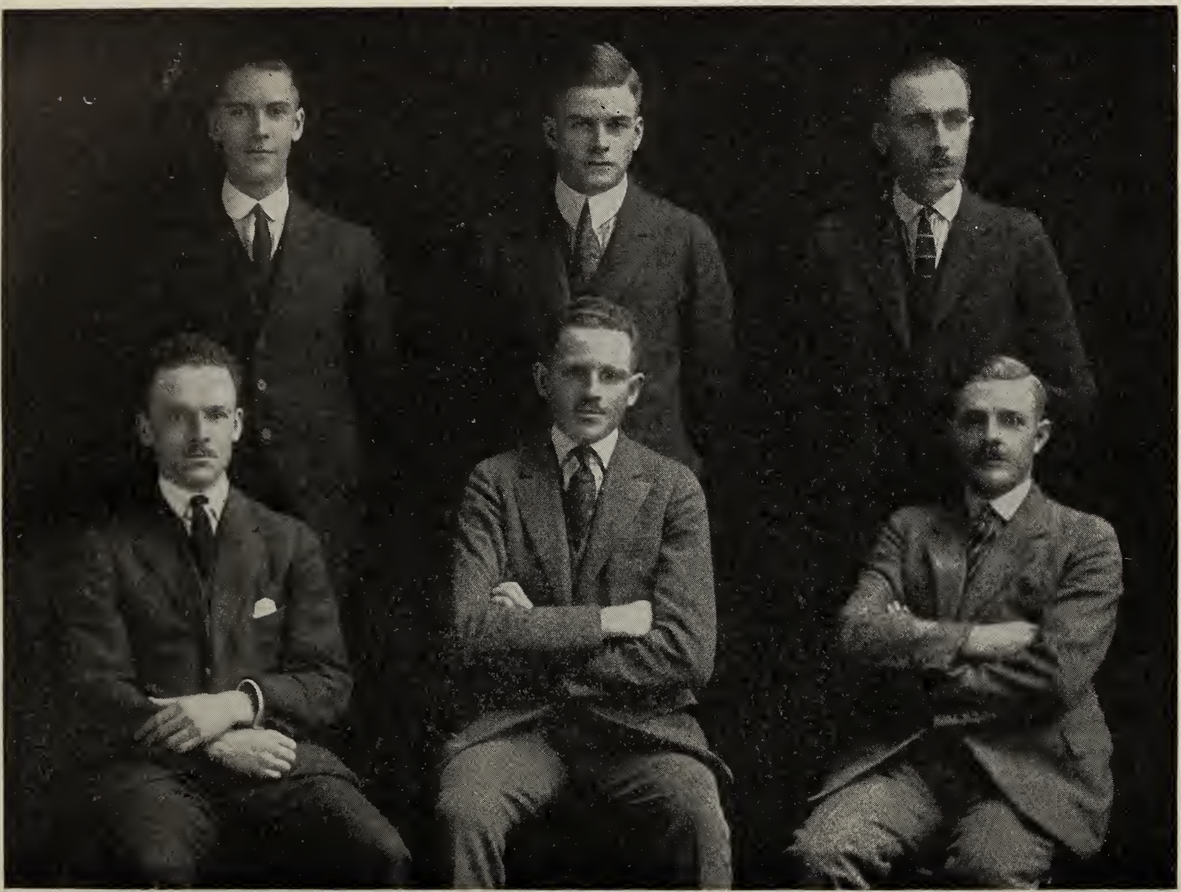
At the next smoker the Club was addressed by Mr. P. G. Kiely, secretary of the Standard Stock Exchange, on the "Relation of the Stock Exchange to the Mining Industry." This was a very interesting address and called forth much discussion. Mr. Kiely's address, in addition to giving a few sidelights on the financial end of mining, outlined several sane principles of mining finance and investment which, if followed, would tend to minimize the degree of speculation in this class of stock.

Following the holidays, the M. and M. Club in conjunction with the Architectural Club held a successful dance at the Metropolitan Assembly Rooms. The competition in a "Paul Jones" between the two clubs provided an exhibition of unequalled grace. It was thought at first that the Architects, through their familiarity with Grecian art, would have the M. and Emmers at a disadvantage, but so well did the latter acquit themselves in "tripping the light fantastic" that Prof. C. H. Wright, who acted as judge, was unable to decide the winner and called in the goddess of chance, who bestowed the apple on the Architects.

At a meeting of the Club in February, Mr. C. E. MacDonald addressed the members on the "Production of Nickel and Its New Uses in the Industry." This was illustrated by three films on the nickel mines and smelters at Sudbury. The address was very instructive and timely in view of the recent developments in the nickel market.

Throughout the year the members have had access to the meetings of the Toronto branch of the C.S.M.M., a privilege of which many have availed themselves and which we wish to acknowledge. We also desire to thank the officers and members of this organization for their kindness in inviting Club members as guests to their several luncheons, and to express our appreciation of their hospitality.

"——— seeking riches"



MINING AND METALLURGICAL CLUB.

TOP ROW:—

W. Hansen (II. Year Rep.).
J. G. Ironside (Chairman Entertainment.).
J. S. Dickson, (I Year Rep.).

BOTTOM ROW:—

G. C. Mutch (Vice-President);
W. S. Maguire (President);
A. G. Horning (Secretary-Treasurer).

We mention here a departure which, while it has concerned only a part of the Club, has been of great value and is well worth repeating next year. This is the series of talks given each Friday morning to the Fourth Year miners by prominent mining engineers, geologists and mining lawyers, on the development of mining claims and the organization of mining companies. This series of addresses has been arranged by the students. The thanks of the class are due these speakers, who have generously and freely given their counsel and time.

In conclusion, I would like to take this opportunity of thanking the executive for its co-operation and the Club as a whole for its support. In the coming year, K. C. Gray has been chosen chairman, and under his direction we bespeak a successful year.

On behalf of the 2T3 members I wish to bid adieu to the Club. With it we shall ever associate some of the happiest remembrances of our four years at School. We wish it every success in the future.

W. S. Maguire.
President M. and M. Club.

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# ARCHITECTURE

"*Every day in every way the Architects are becoming clubier and clubier.*"

With the largest membership in its history and a live executive, the Architectural Club has successfully upheld the traditions of former years.

Owing to the nature of the curriculum, the club is more or less self-contained, and, although the spotlight plays with greater brilliancy upon other organizations in School, the Architects are not so far upstage as one might imagine.

The small membership of the club enables the executive to keep a fraternal eye upon the overworked frosh, the underworked sophs, the can't-work juniors and the won't-work seniors. This promotes a "delightful intimacy" (bring your knitting to the next meeting, Melissa) between the uproarious first year, the laborious second year, the stentorious third year and the glorious fourth year.

The good ship "Double Elephant" having weighed anchor (578.3 lbs. S.R.) and having signed on the following as ship's company, steamed away on her voyage early last October:

Rear Admiral—Mr. J. P. Hynes (Pres. O. A. A.)
Front Admiral—Mr. H. H. Madill.
Captain—A. Scott Crawford, '23.
Mate—Miss J. M. Hall, '23.
Steward—J. D. McLean, '23.
Purser—W. E. Carswell, '24.
Chief Engineer—H. A. McIntyre, '23.
2nd Engineer—W. P. Lawson, '24.
Stoker—F. J. Wallis, '25.
Cabin Boy—G. S. Screaton, '26.

Ensemble—Deck Hands, Look Out, Look In, (Erratum, Etide, "Look In." We didn't have one).

Costumes by J. G. Magee.

Note—In the course of the voyage one soul was washed overboard during a storm.

Within the department is an organization which, although almost totally unknown to the average Schoolman, is worthy of special mention—namely the Architectural Club Quartet. This band of songsters has helped to shorten the tedious hours of night work in the studio and has been heard by numerous nocturnal prowlers who frequent the musty corridors of the Little Red School House.

The first meeting of the year took the form of a dinner at the Inglenook Tea Rooms on Oct. 24th, 1922. There was a record attendance and from every point of view the gathering was a success. After dinner short speeches were given by the Hon. Pres. Mr. Hynes, the Pres. A. Scott Crawford, Prof. C. H. C. Wright and Mr. W. A. Golding. An amusing feature of the evening was the initiation of the freshmen. Each one was called upon to speak for three minutes on a trivial subject received earlier in the day from the sophomore committee. A great deal of originality was shown in dealing with these subjects. Following this the freshmen were taught the Psalm of Life and the Toike Oike under the able direction of Don. Ross.

On Tuesday evening, Jan. 23rd, 1923, the club again met at dinner, this time at Mistress Polly's Tea Place. After an excellent dinner, Prof. T. R. Louden addressed the club on the "Relation of the Engineer to the Architect." His remarks covered many interesting and important points not included in the regular lecture course. The club wishes to take this opportunity of thanking Prof. Louden for the interest he has always taken in the boys and especially for honoring us with his presence at this meeting.

Saturday evening, Jan. 27th, was a memorable night. On this date the "T-square artists" combined forces with the "pick and shovel gang" and staged what both the Architects and Miners claim to be the best Saturday Night Dollar Dance of the year. There was a splendid turnout of

U. OF T.
ARCHITECTURAL
CLUB
EXECUTIVE.

TOP ROW:—

G. S. Screaton,
(I Yr. Rep.);
A. W. P. Lawson,
(III Yr. Rep.);
W. E. Carswell
(Treasurer);
F. J. Wallis (II. Yr.
Rep..

BOTTOM ROW:—

H. A. McIntyre
(IV. Yr. Rep.);
A. Scott Crawford
(President);
Miss J. M. Hall
(Vice-President);
H. H. Madill
(Grad. Rep.);
J. D. McLean (Secretary).

both departments and the great success of the Weekly Dollar Dance was again demonstrated. The feature of the evening was a Paul Jones Competition between the two departments represented. Prof. Wright acted as judge, and being unable to declare a winner on the merits of the dances, he asked the two club presidents to come forward. The latter had to guess the number of keys on Prof. Wright's key-ring. Scott Crawford won out for the Architects and was presented with a large box of humbugs.

Of special interest to the club was the visit early in February of Professor Paul P. Cret, of the University of Pennsylvania. Prof. Cret is probably the foremost architectural designer on the continent and he came to Toronto for a few days as the guest of the university to give studio criticisms to the undergraduates in Architecture. While here Prof. Cret was entertained at the Arts and Letters Club and his address on the gigantic town planning scheme, which he has developed and is now carrying out in the City of Philadelphia, was of great interest to all those who were fortunate enough to be at the dinner. The Architectural Club had planned a dinner and theatre party in honor of Prof. Cret, but he was unfortunately forced to return before the date on which this social event was to have taken place. However, much good was derived from Prof. Cret's visit and the only regret was that he was unable to be with us for a longer period.

Early in April the Annual Exhibition of the Architectural Club will be held in the Sketch Room, Hart House. Preparations are already under way for this display of the work of the department. This exhibition is becoming one of the annual institutions of the university, attended not only by the undergraduates of all faculties, but by the members of the profession and many friends of the university. Full announcements will appear later in the Varsity, and everyone interested is cordially invited to attend this exhibition and become better acquainted with the work done in the Department of Architecture.

Later in the term the annual election of officers of the club for the session 1923-24 will be held. On several occasions this event has developed into quite a party. However, we will make no predictions for the current year. Suffice it to say the best traditions of election day in the Architectural Department will be upheld, including the bonfire.

The executive is arranging to hold a "bang up" social function to top off a very successful year. Many suggestions for this affair are under consideration and at present no official statement can be given out regarding the form the celebration will take. However, the affair will maintain the high standard of all School functions and will doubtless be one long remembered and in a class with the Graduation Dance of 2T3.

In conclusion, the president desires to thank the members of the executive for their valued assistance and enthusiastic co-operation in carrying out the work of the year. Thanks are also due to every member of the club for their support and for the way in which they attended meetings arranged by the executive. May we take this opportunity of wishing the incoming president and his executive every success and the abundant support that we have enjoyed this year.

A. SCOTT CRAWFORD, President, Architectural Club.

# THE SCHOOL DEBATING CLUB

The Club has endeavored during the last year to create more interest in debating generally throughout the school, and has met with real success. It has not only shown to the Schoolmen that they need not feel outclassed by the more purely cultural faculties, but has shown that the debating talent at the School of Science is equal to that of any.

The year's activities were started with one of Professor Greave's very instructive and entertaining talks on "Some Principles of Public Speaking." Professor Greaves showed the Club how they should control and use their vocal organs in speaking. A successful speaker needs much practice to properly develop and use the voice. Five other meetings were held, all taking the form of debates. The first and fourth years were winners in the first round of the Inter-year debates, and in the final round the first year defaulted to the fourth.

The Club met unparalleled success in Interfaculty debating this year. The eloquent theologians of Wycliffe yielded to the sound judgment of Messrs. Rowat and Emerson in the first round. In the second round W. Osborne and J. Dymond proved to the university that the Science Faculty was not inherently less able to debate than University College. In the semi-finals Messrs. Murray and Price, although not able to defeat McMaster, showed that Schoolmen were very worthy opponents of the premier debating college of the university. Mr. John Dymond very ably represented the university in the Inter-collegiate series, which was won by Varsity. His eloquence and forceful debating style drew great commendation from all those who had the privilege of hearing him, both at Toronto and Montreal.

At the last meeting of the Club executive it was unanimously agreed that one of the difficulties in arousing interest in public speaking and debating in S. P. S. was the fact that S. P. S. students will not talk in public purely for the sake of talking. Discussion purely for the sake of discussion outside of laboratories is not entered into with any enthusiasm. In view of this fact, the executive recommends that as well as the scheduled debates and an occasional speaker on some phase of public speaking, the Club should work with the five departmental clubs and hold five joint meetings throughout the year. For these meetings the program of speeches and discussion should be supplied entirely by the students themselves. In

SCHOOL DEBATING CLUB EXECUTIVE.

TOP ROW:—

R. E. Knowles (1st Year Rep.); N. E. McPherson (2nd Year Rep.); A. F. Murphy, (4th Year Rep.).

BOTTOM ROW:—

S. L. Grenzebach (Secretary-Treasurer); Prof. E. A. Allcut (Honorary President); A. V. Price (President); G. H. Ro t (3rd Year Rep.).

this way topics of common interest would be debated and discussed, and the aim of the departmental clubs to increase interest and knowledge in their particular branch of engineering and the aim of the debating club to foster and develop speaking in public would be realized.

The executive also realized that the work which the debating club is endeavoring to do, that is, to teach and develop public speaking in the Faculty of Applied Science, is in reality endeavoring to add another study to the curriculum. This is done because it is felt that those in authority do not supply the instruction for this branch of our development. The executive feel that a large portion of this work could be much better and more easily accomplished by the faculty instead of by a group of undergraduates, and benefit not a few but the whole school. Speakers addressing the students are continually stating that one of the most important attributes for a good engineer is to be able to clearly express himself in a pleasing and convincing manner in writing, in discussions, and in public speaking. These speakers also emphasize the fact that many of the details in the course considered important at the time will be entirely forgotten after graduation, but any training such as in the proper use of the English language under all circumstances will always be of great value. Many students at present in S. P. S. are at a loss to know, if these speakers are correct, why the faculty do not make a more definite attempt to develop in the School of Science a greater appreciation for the proper use of good English, both written and spoken.

A. V. PRICE, President Debating Club.

# SCHOOL Y.M.C.A.

The first, and one of the very important events of the year, was the "Frosh" reception. Due to the efforts of the committee in charge, the affair was a decided and joyful success. The main purpose of this gathering, to make the freshmen feel at home and to acquaint them with some of the more important men in the senior years, was certainly fulfilled. The entertainment, put on by the freshmen themselves, was enjoyed by everyone and much undeveloped talent was uncovered.

The handbooks were distributed through the "Y" organization as usual, and were better than ever.

The various committees carried on their work as usual and were very successful.

S.P.S.
Y.M.C.A.

TOP ROW:—

G. W. Smart (Campus Service);
T. H. Jenkins (II. Year).

BOTTOM ROW:—

J. Beattie (III. Year);
Prof: R. A. Angus (Honorary President);
J. C. Dumbrille (President);
A M. Reid (I.R.C. Committee).

Tony Reid's child—the International Relationships Committee—had a very interesting and successful year. Many papers were read and discussed and the results, while not commeasurable in actual monetary value, were certainly of immense benefit to those taking part.

The Y. M. C. A. took up the Students' Conference which was held at Xmas this year and we had a representation of ten men there. This conference was the first of its kind and was interesting to everyone; but any description of it would be superfluous as the Varsity has described it in detail.

On the whole we had a successful year and I am sure can look forward to better results next year under the hand of John Beattie, the new President. We who are leaving, realize the good we might have done and the opportunities we missed, but we know that our successors have seen our errors and will profit by them. Anyway the new president is a Miner —"nuff sed."

JOHN DUMBRILLE, President.

# THE ENGINEERING INSTITUTE OF CANADA

The history, aims and activities of the E. I. C. are perhaps known sufficiently well by "Schoolmen" to make any detailed reference unnecessary here. An excellent address covering the subject is contained in last year's "Transactions," should anyone desire such information.

The past year has seen growth in the Institute throughout the Dominion. In co-operation with other societies it was instrumental in having The Professional Engineers Act of Ontario passed last year (1922). While not giving as much protection as was hoped for, it is, at least, a start, and schoolmen are asked to support this new organization and join when their qualifications permit.

During the year there has been a healthy interest shown by students in the meetings of the Toronto branch of the E. I. C. In recognition of this interest the chairman, Mr. Wm. Storrie, set aside a regular meeting as "Students' Night" during the fall term. Papers were presented on "Power Factor," "Overhead Cost-Accounting" and "Refractory Materials," by Messrs. F. A. Ellis, D. B. Strudley and H. F. Robertson respectively. A crowded audience of seniors and juniors was at hand, and the greatest possible appreciation was expressed for the character and delivery of the papers. Students also took part in an informal dinner at the beginning of the New Year, the entertainment furnished by our Hawaiian musicians being received with special enthusiasm.

The council of the Institute has recognized the value of student activities by appointing a Special Committee to report on the best methods of linking up the students with the E. I. C. The fact that Prof. T. R. Loudon and R. W. Downie—both past presidents of the Engineering Society—are serving on this committee insures that suggestions and recommendations will be in line with school sentiments. The other members of the committee are the Chairman, Geo. R. McLeod of Montreal, A. M. Reid and F. J. Lyle, the latter in an advisory capacity. While it is not in order to go into any detail regarding this report, as it has yet to be submitted to the Council of the Institute, it may be safely noted that it is strongly recommended that at no time should a Students' Branch of the E. I. C. be formed in S. P. S. The Engineering Society must at all times have the right of way and retain unquestioned control of undergraduate activities. Nevertheless there is need for a thorough presentation to the undergraduate body of the position of the E. I. C. in Canada, and a greater development of contact through the local branch with the graduate engineers in Toronto. The report deals with methods for accomplishing these desirable ends.

The future of E. I. C. activities in School rests entirely with the student body. There are difficulties in the way, and it may be expected that occasionally, as in the past, the situation may demand tact and caution, as well as enthusiasm. The problems of the Institute are, however, the problems of the Canadian Engineer, and in supporting it as students and after graduation by efforts and constructive criticism Schoolmen will be doing their bit towards advancing the interests of the Profession.

A. M. Reid.

2SPS3

The Class of '23 ('24 Meds) is without a doubt the most unique and impressive class that ever did, and if we may speculate on the future, ever will cross the portals of the University. It is a direct result of the cessation of the greatest conflagration that has ever swept this universe. Four years of youth, who, under ordinary circumstances would have come to University in their respective years, found more urgent things to be done. They did their duty to the end and it was then we found four years concentrating themselves in one and forming the classes of '23.

2T3 Science is composed of men with a wide divergence in age from the old soldier who went over in 1914, to the young recruit and the lads just out of high school in 1919. It is composed, you might say, of men who have held ranks at some time or other, varying from general to that of acting private, without pay, for the younger ones were truly acting privates even if circumstances prevented them from getting the pay.

IV. YEAR EXECUTIVE, S.P.S.

TOP ROW:—J. G. Ironsides (M. & M. Rep.); H. F. Robertson Chem. Rep.); F. W. Huggins (Varsity Rep.); C. H. Lucas (Ath. Rep.); H. A. McIntyre (Arch. Rep.); J G Inglis (Elec. Rep.).

BOTTOM ROW:—H. G. Clappison (Civil Rep.); G. E. McClellan (Secretary-Treasurer); R. G. Morrison (President); Dean C. H. Mitchell (Honorary President); H. B. Keenleyside (Vice-President); J. E. Goldie (Mech. Rep.).

ABSENT:—A. S. F. Murphy (S. A. C. Rep.).

There is much that can be said for our members who, on account of age and disability were not privileged to accept the King's shilling. In our united efforts they have certainly done much in putting 2T3 in the position it occupies to-day, and furthermore, they have shown us that three or four years in the army is not an essential for the making of a man, although it may have its advantages. We started in, in the fall of '19, 401 strong, and three years of university life and examinations have collected their due. Of the 401 that started we have barely 225 left. We have had reinforcements from other years and universities though, and to-day the year numbers 256 men (horse, foot and artillery). Our tremendous casualties are due to all the troubles with which a student is afflicted, from too much social or athletic activity, to that of N. S. F., on which most of us can speak with authority.

Looking on the brighter side of things we who are either awfully lucky or very hard working, or both, have been favoured with associations during the last four years the equal of which we can never hope to encounter again. We have got to know each other and our thoughts, our ways of reasoning and outlook on life, have without a doubt been influenced for the better. We all have our faults and limitations but it is reasonable to believe that by constant association with others who are not afflicted with these particular shortcomings, ours should be reduced to a minimum.

Consider any individual whom you have known from the first year; is there not a great change for the better in him? If he was an extremist in any one line I think you will be bound to admit that he has moderated considerably, or at least developed a tolerance for the other fellow's point of view, which is a great asset to him. Consider yourself, aside from any technical knowledge which you might have accumulated during your sojourn here, are you not an entirely different man from when you began? You can't help but be, even if the difference is of that intangible variety which is akin to a woman's smile.

The Year has among its members leaders in every line of thought and in most lines of human endeavour, that would reflect credit on any body of men (with apologies to Miss Hall).

Our contributions to university activities have been of a highly creditable nature and I can safely say that we have had men taking part in each and every one.

In athletics we have always held our own whether inter-year, inter-faculty, or intercollegiate. We have had men on every first team representing the university at some time or other. We are honoured in having in our midst a Varsity rugby captain and an individual track champion, to say nothing of the men who have won T's several times over. In all, we have with us 24 T holders and 58 S holders, which brings our quota above that of any other Year in the University, and their efforts have ever been followed with the loyal enthusiasm which they deserve.

We have had one of our numbers President of the Engineering Society, which in itself is no great accomplishment as one of the fourth year must needs fill the job to the best of his ability. The distinction comes in having one of our own men fill the job in such a capable, energetic and resourceful manner as our genial, curly-haired friend, Pat, has done, and I wish to take this opportunity to express the admiration and respect of the Year for his successes, which have reflected much credit on us as a whole.

The University at present is governed as Sparta was of old, by two kings, one acting as a restraint upon the other. Representing the kings we have two groups of men, the older element with the reserved judgment of experience, and the younger element filled with youthful vigor and enthusiasm, and possibly a few degrees more rashness. The combination results in a most satisfactory state of affairs; just enough giddiness to satisfy the impetuosity of youth and enough reserve to keep the more stable element from growing prematurely gray haired.

One frequently hears representations as to just what will happen when the older element is removed. Will University life divert towards the side of frivolities and foolishness or will it keep on the level course on which it is at present? From my personal observations I am led to believe that the fate of the University can safely be left in the hands of the junior years, as they have to date shown an adaptability to, and a capability for, managing things which at first surprised most of us.

The Executive this year has done its utmost to keep 2T3 activities up to the standard set by former executives. We assumed that our fall dance held at Columbus, Oct. 26, was an unqualified success as our resignations were not called for immediately afterwards. Our graduation dance at the King Edward, Feb. 22, was aimed to be of that quality which is a fitting climax to the activities of a very remarkable year. As no one has offered much criticism we, the Executive, think we are taking no liberties when we say that it achieved its object. With regard to the graduation dance I wish to express the appreciation of the Executive to that resourceful gentleman who so opportunely pinched the lucky supper programme and let Professor J. Roy Cockburn and his partner, Mrs. Mitchell, down so hopelessly in the elimination dance. Without a doubt it was the most popular event of the evening.

Our permanent Executive will soon be taking over office and we know from experience that they are the most fitting men for the positions, and we can safely trust them to look after our interests in the years to come.

In closing I wish to express my appreciation to the Year in general and the Executive in particular, for their hearty co-operation and energy in executing all things undertaken, in such a satisfactory manner.

The thanks of the Year from when it first entered the University are also due J. H. Brown and M. G. Evans, who have given liberally of their time and skill at most Year functions. In fact I cannot recall a Year dance at which one of them was not officiating as general superintendent.

R. G. K. Morrison,
President 2T3.

# 2T3 “T” Holders

| | |
|---|---|
| Jack Goldie | *Boxing* |
| R. C. Relyea | *Boxing* |
| F. S. Seabourne | *Boxing* |
| A. A. Bell | *Rowing, Track, Water Polo* |
| J. C. Harston | *Swimming* |
| A. Conklin | *Swimming* |
| A. M. Fitzgerald | *Swimming* |
| C. M. Wells | *Swimming* |
| G. Lindsay | *Swimming* |
| H. L. Kennedy | *Hockey* |
| F. Evans | *Hockey* |
| G. G. Duncan | *Rugby* |
| E. Rolph | *Rugby* |
| H. E. Wingfield | *Soccer* |
| M. G. Evans | *Soccer* |
| N. F. Johnston | *Soccer* |
| H. Duffill | *Basketball* |
| C. H. Lucas | *Soccer* |

# Ex-Members of 2T3 “T” Holders

| | |
|---|---|
| A. Carew | *Rugby* |
| F. Sullivan | *Rugby and Hockey* |
| M. D. Earle | *Rugby* |
| Glad Thompson | *Hockey* |
| M. Wolsey | *Gymnasium* |
| J. Smith | *Rowing* |

# 2T3 GRADUATION DANCE

There are dances and dances, but the graduating dance of a notable year is the one which leaves memories which will remain long after the class has gone out into the world. When, for the last time, men who have worked and played together for four full years gather to celebrate the passing of the final milestone, gaiety is tinged with just a little sadness and each moment seems to pass all too quickly.

Such was the Graduation Dance of 2T3 School held at the King Edward Hotel, Thursday evening, February 22. For the brilliance of setting, for completeness of appointments and for a spirit of whole-hearted enthusiasm and good fellowship, the affair was the best of a series which had established the fame of the class in the realm of entertainment. From nine o'clock until three in the morning each hour was crowded with real enjoyment, and such was the excellence of the arrangements that a new standard was set for smoothness in the carrying out of the program.

The patronesses were Mrs. C. H. Mitchell, Mrs. P. Gillespie, Mrs. J. W. Bain and Mrs. T. R. Loudon, and a real honour was paid to the Year by the manner in which they entered into the spirit of the affair. A feature of the evening was the duet by Messrs. Walker and Grant, while the 2T3 quartet entertained with several pleasing numbers. Most striking among a number of original novelties, was a huge black cat mounted in the balcony, from which came a shower of balloons to descend upon the merry makers. Later in the evening bright coloured tickets and whirligigs wer passed around and provided much amusement. Particularly effective was the skilful handling of the illumination and spotlights which made of a gay scene, a veritable fairyland. Supper was served in the foyer, the galley and the sitting-out room, a feature which substantially aided in the efficiency of the arrangements.

The most delightful event of the evening was the elimination dance, which was carried out by means of supplementary examinations indicated on the individual programs. The winners were Prof. J. Roy Cockburn and Mrs. C. H. Mitchell, which caused much consternation among the judges. It was finally decided to give Prof. Cockburn a test in Descriptive Geometry, in which he proved his proficiency by drawing a straight line through any three given points, and was awarded a diploma as third-class stationary engineer.

For their successful leadership of the troops, the three ex-commanders of the 2T3 School Battalion, Messrs. A. M. Reid, A. A. Bell and John Farley, were presented, on behalf of the Year, with gold pencils by the G. O. C., General Mitchell.

The Year Executive, Messrs. R. G. K. Morrison, G. E. McClellan and H. B. Keenleyside are indeed to be congratulated upon the excellence of a dance second to none held before, in the King Edward, or elsewhere,

So was the social life of 2T3 brought to a close and memories of the last dance will come to many whenever their minds turn to thoughts of the Old School.

SPS
APPLIED 2T4 SCIENCE

Last September found many of the class among the missing and the casualties from the spring offensive, but our numbers were increased to almost their original total by another large re-enforcement from 2T3, and by several students from other colleges.

The desire of the class to dance was evident the first week of the term, so Ed. Carswell organized a group who were famous for their work and ideas on dance committees and began planning the decorations, novelties and arrangements for the annual dance which was held late in October in Columbus Hall. The success of the whole evening justified the great amount of work done in preparation and went further to show that 2T4 can stage a dance in which organization, completeness of detail and originality cannot be surpassed. The Year Dollar Dance at the Metropolitan Assembly Rooms in the second term was enjoyed by all, and such a good time was had without requiring any organizing that more dances of this variety may be expected next year.

After the joy killing effect of examinations at the beginning of the second term it was thought necessary to remove this evil effect by holding a real smoker, so accordingly the class assembled in Hart House and, lead by Jack McLaren, of the "Dumbells," displayed mirth and good fellowship which showed they were all good sports and were willing to be the source and recipient of merriment.

The success of a class or a unit in a large university like ours is not wholly determined by the organization and originality of their dances and the pep of their smokers; but greatly by the number of the class who take an active part in Faculty and University activities and sports. A great number of men of 2T4 have become active in various Faculty and University activities, and in sport the Year is as well represented as any. Among these activities 2T4 can be justly proud of the active interest taken by the members in the Debating Society; when they were freshmen a revival of the Debating Society was held and since that time 2T4 has been the main support of that organization in School. This year two different teams from this class defeated Wycliffe and University Colleges in debate; this and the choice of Jack Dymond to represent the University is a record that any class might well be proud of. In Intercollegiate and Faculty sport the Year was well represented and credit is due to the many men who gave their time and energy freely to bring honor to their Faculty and University.

Considerable success has attended the efforts of the three Year committees 2T4 has had so far, and may the last be more successful. With Fred Becker as President, assisted by Gordon Robertson and Art Colman, the class will complete a remarkable University career.

W. J. W. Reid, President.

The Year did its best to be an exception to the rule but, nevertheless, we lost some men to 2T6 owing to the April shower of exams. There were others also who, may it be said, preferred to graduate belonging to the class of 2T5, in 1922, rather than throw in their chances with the Freshman year. These losses were, however, ably compensated with promotions from 2T4. After all was said and done, we started the year with a strength of a hundred and sixty-six.

The Year first got together at a cracking good smoker in October, and, as the bumptiousness of the Freshmen could not be tolerated any longer, plans were made to give them a good old School welcome in the near future. Bill Turner was in charge of the proceedings and it was largely due to his untiring efforts that the evening was such a success. Under his leadership everyone was given their bit to do at the coming initiation.

The initiation, when it did come off, did not run along the lines originally planned. Nevertheless, it served its purpose, inasmuch as it bound the First and Second Years together with a tie of friendship that could not in any way have been bettered.

In December, at the Carls-Rite Hotel, the Freshmen, as our hosts, tendered us a royal banquet and the evening will long be remembered by all who attended. The members of the year of 2T6, and especially their executive, are to be congratulated on the novelty and wonderful success of the evening.

The next event of importance to the Year was the Year Dance held at the Metropolitan Assembly Rooms under the paternal guidance and chaperonage of Digby Wyatt. Although it is contended that 2T5 are not "trippers of the light fantastic," nevertheless, the "gang" turned out in goodly numbers and two hundred of the Year and their friends enjoyed a wonderful dance.

Credit is due Eric Taylor, Ross Dickenson and Dave Lloyd for the success of the 2T5 booth at School Night in Hart House. The Year ran a game of chance and everybody present either gambled or gambolled at the booth. A grand prize was presented to the winning couple while all those competing were the recipients of lucious lollypops and evidence of their enjoyment was illustrated by the stickiness of the Hart House corridors for weeks afterwards.

Yet another family gathering took place in the form of a smoker under the able management of Doug. Morton. The event happened at Hart House early in February and, with the assistance of Jack McLaren, of the "Dumbells," everyone sang whether they had a voice or not. Interdepartmental boxing and wrestling were features of the evening.

The Year played a prominent part in all Interfaculty and Intercollegiate sports. Twelve Second Year men helped the Junior School football team bring the Mulock Cup to The Old Red School House once again, while the boxers and wrestlers of the Year captured the championship at the S. P. S. Assault-at-Arms. We were also well represented on both the Soccer and Track teams.

As we progress into our third year (and here's hoping we all come through!) the Year gets broken up into Departments and there is danger of the Departments becoming isolated, but, if the Executive are given good support and everyone pulls together, there should be no fear of this. In closing, the Executive would like to thank the Year for the splendid support it has given. With an excellent Executive elected for the coming year there is no reason why we cannot have a bigger and better year than ever.

PAUL S. WHITE, President.

## 2T6

Everything must have a foundation upon which to build its future accomplishments. It was to this end that the American colonies sought consolidation under the title of the United States and inscribed themselves as "E Pluribus Unum." Surely, when young men gather together from all parts of Canada, from the United States and even the "Land of the Rising Sun," we may truly say that we are met as colonies in a strange land, our cause, education, our bond of unity, a green tie.

As soon as the executive was elected and duly shown its duties by Mr. Lyle, we settled down to business. Initiation was our nearest problem and formed most of the conversation which one heard in the class rooms. As a class we had our ties pulled out and our hats taken off with but a smile of passiveness, until the time came, when to make it gayer for the Sophomores we assembled outside, gave a Toike Oike and rushed into the building for anything and everything. We certainly got everything it seemed, but it took quite a few to do it, so that afterwards we felt one step nearer to being an engineer.

Prior to the big day, the first and second year executives met in the Dean's office, and then things happened fast. The night arrived and so many things took place that only those who attended it can ever fully appreciate what can be done in one evening. The result was that we were treated to a wonderful evening which was brought to a close in Convocation Hall.

In consideration of this attention from our Sophomore year, we then set about to give our best in the most suitable way. The theatres were dumb to our supplications, so that we finally decided to tender a banquet. To this end the committee worked unselfishly, sparing no expense or time. On Wednesday, December 13th, 1922, both years met in the Blue Room of the Carls-Rite Hotel. President Sir Robert Faulkner and Dean Mitchell were our guests of honor and, of course, a source of pride for the First Year. Bill Turner's Jazz Band supplied the music while Mr. Jules Brazil, assisted by some of the original Dumbell cast, an operatic singer and a few comedians, made an evening's enjoyment all too short. I might say that after hearing Red Newman we had quite an epidemic of "Oh, What a Lovely War." In conclusion to the evening Mr. Church gave us a few words and delighted us with his seriousness.

After our Christmas vacation we began to look forward to a smoker, and on Feb. 2nd, 1923, we met in the East Common Room at Hart House to enjoy a real good evening devoid of all frills. Our class orchestra made its initial bow to us and by all appearances it will be a big asset to our year. Miss Complin made *his* debut as a ballet dancer, while wrestlers grappled until black from dusty mats and the boxers bid fair for the Intercollegiate title. The two cannibals, introduced so aptly by Mr. Knowles, fought a fight to the finish, and everyone having eaten to satisfaction showed themselves well pleased and easily repaid the committee for their time.

We have also sought the athletic field, as will be seen from the following names:

*Rugby*—

Varsity Senior O. R. F. U.—J. Carrick.
Varsity Seconds—W. Bentley and H. Irwin.
Varsity Thirds—F. Bruce and N. Scott.
Jr. School—F. Buckland, T. Rogers, E. Burbank, F. Roelofson, R. Complin, F. Sampson, D. Dow, E. Cash, A. Hughes and M. Johnson.

*Soccer*—

Jr. School—C. Armour and L. Barnes.
Interscholastic—C. Armour.

*Hockey*—

Varsity Jr. O.H.A.—J. Carrick.
Jr. School—A. Sutton, J. Auld, E. Allen and W. Bentley.

*Basketball*—D. Dow, F. Buckland, C. Armour, F. Patterson, C. Rogers and F. Roelofson.

*Track*—C. Morrison, H. Ruggle, R. Innes, M. Gooderham and W. Thompson.
*Boxing*—A. Ormerod, F. Hunter, H. Norman and H. Griffith.
*Wrestling*—R. Knowles and K. Gordon.
*Fencing*—F. Barr.

Besides these men, inter-department basketball players are fighting it out for the championship and crests.

We are also on our way to the debating shield and expect to earn it before the year is out. Our first victory was earned by E. Davies and C. Armour against the Third Year.

Owing to the willingness of my classmates to support their executive, things appear to have gotten away to a good start and there is no reason that next year and the ones that follow should not be excellent years of University and Class activities. As for next year, under the guidance of Mr. Dow, our welfare is assured and I wish him every success.

As the academic year closes, and I look back over my friendships in School, it is a source of pride to me to feel how kindly I have been advised by many of our Seniors. Mr. Lyle has done everything possible for me and consequently the year, and Mr. Dymond, who so unselfishly counselled us through the investigation, cannot be forgotten. It is in recognition of such generous service that I offer my humble thanks for my year as a close to our work.

C. V. Armour, President, 2T6.

# THE TOIKE OIKESTRA

The work of the orchestra was made possible by the Engineering Society providing a piano and the necessary funds for music. The usual enemy, slim attendance at practices, threatened at times, but the custom of holding practices between five and six o'clock and of giving them good publicity helped in this respect.

The School Dinner was the most important event at which the orchestra appeared during the fall term. The universal feeling of good cheer makes it a pleasure to play at such gatherings and this was no exception to the rule. In addition to this the orchestra played at a number of the meetings of the Engineering Society.

"School Night" was the big event of the spring term as far as the orchestra was concerned. Playing in the music room and providing opening numbers for the performances of "The Shriek" kept the members busy until the dancing started.

In closing I wish to take this opportunity of thanking Mr. P. S. Edwards and Mr. G. D. Maxwell for their loyal efforts on behalf of the orchestra.

S. R. Muirhead.

TOIKE OIKESTRA

TOP ROW:—P. S. Edwards, G. A. Russell, A. H. Burke, W. R. Carruthers, G. H. Voaden, W. L. Rundle, J. J McCullough, J. H. Fox.

BOTTOM ROW:—J. Johnson, B. C. Griffith, S. R. Muirhead, (Leader); C. T. Carson (Chairman); W. S. Yates, D. Lloyd, D. D. Flett.

# *School Athletics, 1922-23*

## THE SCHOOL ATHLETIC ASSOCIATION

Every year in every way School is getting better and better. Nothing is more amusing than to hear a group of old, corpulent, bald-headed "has-beens" utter the old cry that things aren't now as they used to be. The average human being is very grateful for this state of affairs. The theory that the scholars are not as brilliant nor the athletes as great as forty years ago must be based on fossilized ideas which have not kept pace with advances. Results and results are proof. Nowadays there are more brilliant men than forty years ago, hence a few don't stand out. In athletics records are continually being broken. Swimming has been revolutionized. Hockey was never on so high a plane—there were not the facilities. Track records are being broken. Skating records are being broken. Rowing has been established in two Canadian universities. Team play in all games is becoming more perfected. The use of brains is constantly increasing in athletics.

School has had an excellent year in sport. Both in championships and sportsmanship, Schoolmen may be proud of their faculty. It is the way a championship is won or lost which reflects on the contestants. In this respect, School stands high.

After a lapse of eight years, Jr. School finally brought home the Mulock Cup. Great credit is due the team and all join in congratulating them. Beattie Ramsay and Don Lee formed a great team as coach and manager. It was very unfortunate that Sr. School was prevented by a misjudgment from entering the finals.

Both the outdoor and indoor track championships were retained, along with the Interscholastic Soccer, the Junior Assault and finally basketball. It is a long time since School won the Sifton Cup. Fortunately it was Jr. School and so the players will all be with us for two more years. Like the rugby, Duffill and Smart turned out a real team. The pleasing feature is that in the other sports, in practically every case, School were runners-up and were eliminated only after a tough fight.

School was well represented on all the Intercollegiate teams. Duffill was captain of the basketball team and Keefler of the swimming team. Varsity, as usual, got its share of the championships.

The executive of the Athletic Association is very grateful to the several managers who all did their jobs faultlessly and to whom much of the credit of any successes is due.

S.P.S. ATHLETIC ASSOCIATION.

TOP ROW:—

F. R. Dickenson (II. Year Rep.);
R. H. Keefler, (III. Year Rep.);
W. A. Bentley (I. Year Rep.).

BOTTOM ROW:—

C. H. Lucas (IV. Year Rep.);
A. A. Bell (President);
K. V. Heyland (Treasurer);
J. G. Cade (Secretary).

It is worth mentioning the record of this year's graduating class. Never before was there such a collection of high-class athletes in one class. A record of 24 T's and 58 S's will stand for many years. The graduation of all these men will leave many gaps to be filled which will call for a strenuous effort on the part of School athletes. However, as long as everyone plays a clean, hard game, the full benefit of athletics will be obtained.

The Athletic Association has a fine new executive. If the students will support this executive whole-heartedly, many more triumphs will be accomplished next year. Let it be everyone's duty to get the freshmen started in athletics while they are freshmen.

A. A. BELL, President.

# RUGBY

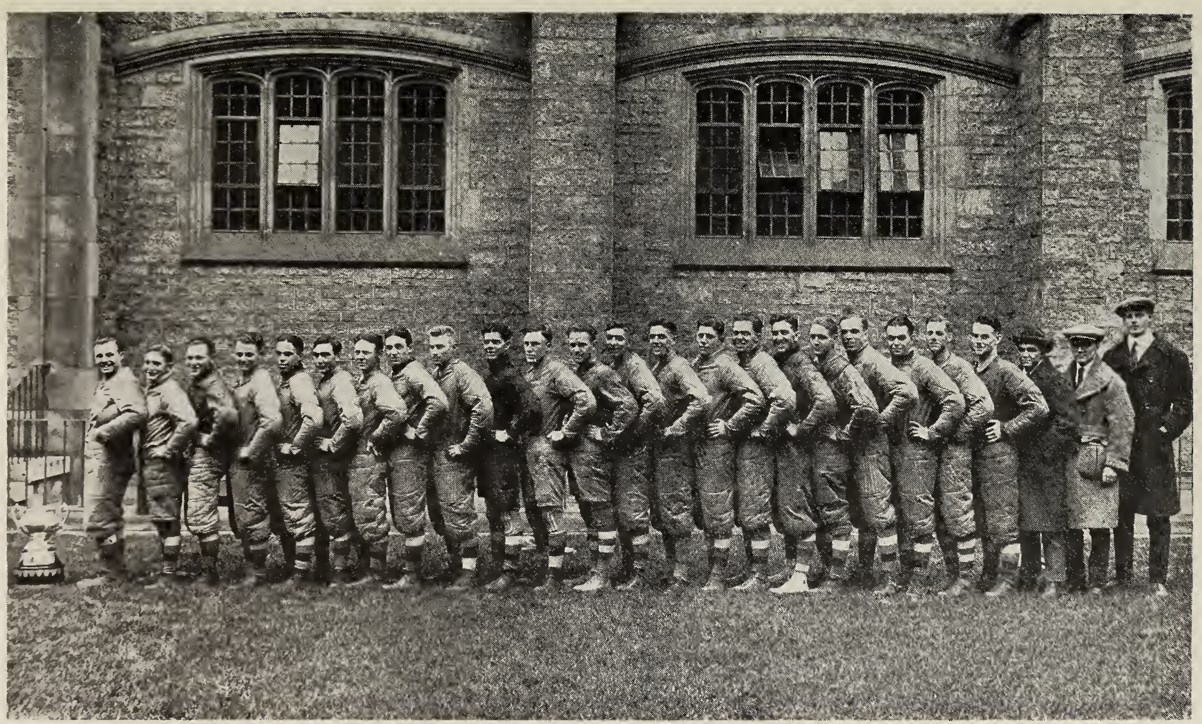
School is back with a vengeance in Interfaculty rubgy. The past season brings back memories of 1915, when Junior and Senior School "fought over the pigskin" in the Mulock Cup finals.

This year Senior School were nosed out by Trinity, due to a little hard luck, an unfortunate decision, not to speak of a fast snappy half line which caught the Seniors napping several times. What Senior School was going to do to the Juniors, if Trinity had not upset the dope, our limited space prevents revealing. However, Junior School have returned the cup where it belongs and we are proud of them. It is the duty of every School man to help to keep it there.

The Junior School team deserves a great deal of credit for their splendid work. Many of their players show great promise and it is to be hoped that some of them will bring further honour to the School by catching a place on the Varsity Senior team.

In 1919 School had eleven men on the Senior Varsity team; in 1920 eight men; in 1921, four men; in 1922, two men. Never in the history of Varsity football has there been a Varsity Senior team without School men represented on the team. Generally, School had the largest majority of men on the team. This spring, the School survivors on the team, Ernie Rolph and Gord. Duncan, graduate. Will the 1923 Varsity Senior rugby team go down in history without a single representative of the old Red School House?

What is to be done? Just this! Let every "School" man who plays rugby, or wants to play, come back next fall in the very best of condition after a summer of outdoor work. Let him turn out to practice with the determination to make that team.



JUNIOR SCHOOL MULOCK CUP CHAMPIONS, 1922-23.

L. A. Booth (Captain); G. B. Sullivan, E. T. W. Bailey, F. R. Dickenson, F. A. Sampson, G. S. Rogers, E. R. Complin, E. A. Cash, G. J. Hughes, F. L. Roelofson, K. F. Parker, H M. S. Pentelow, H. F. Brown, W. G. Lloyd, F. L. Buckland, L. N. Hunter, T. E. Bingham, P. S. White, J. F. Millican, M. H. Johnson, E. F. Burbank, D. W. Dow, W. B. Ramsay (Coach); D. A. S. Lee (Manager); A. A. Bell (President of School Athletic Association).

It will not be on exaggeration to say the result will be that School men of 1923 will uphold the rugby honours which have been set so high in the past by former School men, such as Jack Newton, Hughie Gall, Billy Foulds, Charlie Gage, Joe Breen and many others.

G. G. DUNCAN.

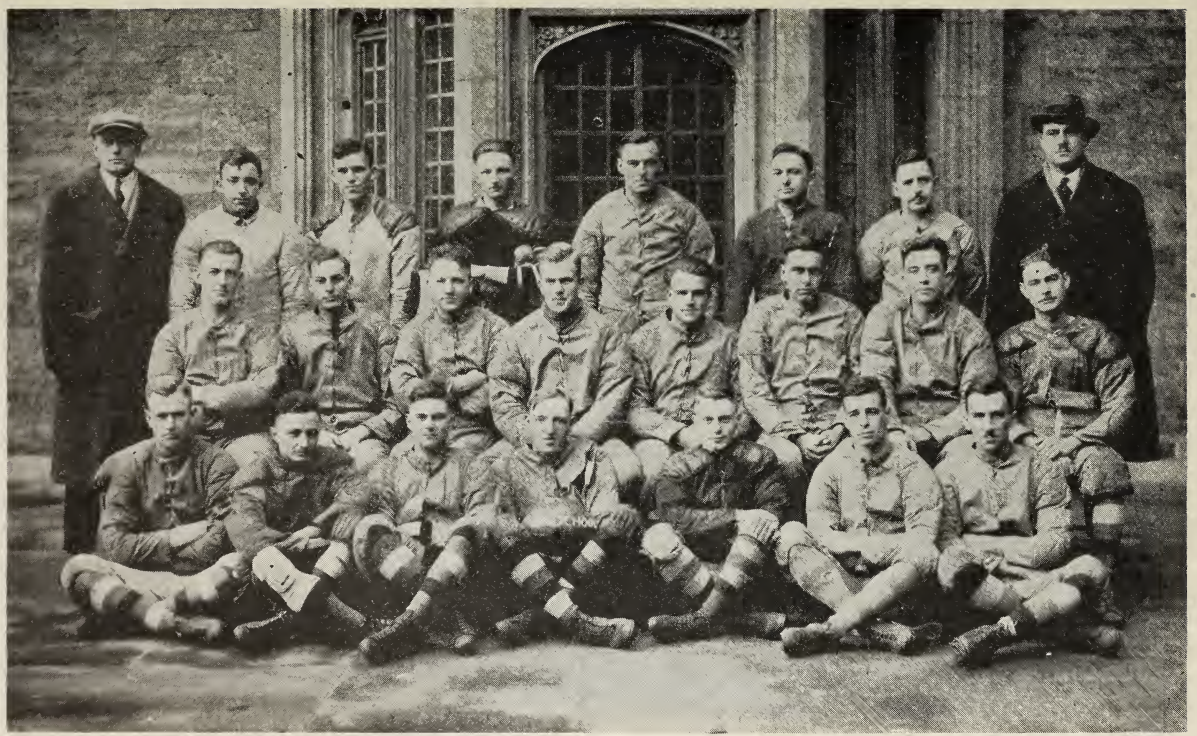
# HOCKEY, 1922-23

Now that it is all over, and we can speak of it in the term of memoirs, it has been, to say the least, a year of hard lost games. From Junior School, Jennings Cup team, to the Varsity 1st team, School men have had once again to show their ever present fighting spirit to combat the misfortune that has followed them all year.

Junior School under the leadership of George Cossgrove were forced to take the ice with little practice, owing to the schedule, and had the misfortune of losing their first game. This fact, coupled with the postponed games which had to be played after the regular schedule when sickness hit the team, left Junior School near the low end of the group standing. Here the youngsters showed their mettle in the fact that although they could not win their group, they made the winners fight all the way to earn their victory.

In Group "A" Senior School and Senior Dents were destined from the first to be thorns in each other's sides. Senior School went through the first part of their schedule without a loss. Then the little "world's series" started with the first game with Dent's which ended in a tie. The next game was a 1-0 victory for Dents. The tie game was replayed with a win for School, 3-2. This made the necessity for another game, and a sudden-death was the verdict. Without a doubt this was the greatest game of the year. Full time found the teams on even terms and even at the end of twenty minutes overtime the score was 5-5. In the last ten minutes the first goal was to decide the game and with both teams nearly dropping from exhaustion, they fought on with all they had. With two minutes to go, Dents secured the winning shot and School left the ice defeated, but with the thought that they had fought their best for School. They were both great teams, and to the pleasure of the School team, Dents finished Jennings Cup champions.

School was represented on all the Varsity teams. Dickenson and Garrick were School's rep's on the Junior team, which was under the leadership of Connie Smythe, a School grad. In the O. H. A. they were defeated in the semi-finals after a hard fight. In the Intercollegiate a very unfortunate incident arose. After defeating R. M. C. in the finals 10-1 without the service of substitutes, owing to a misunderstanding in the rules, Varsity 3rd's had to default the Cup.



SENIOR SCHOOL RUGBY TEAM, 1922.

TOP ROW:—Bert Morris (Manager); A. Conklin, J. H. Coulter, C. Woodburn, J. Goldie, W. Longworthy, C. Sharpe, "Tiny" Houston (Coach).

CENTRE ROW:—L. Kennedy, G. Robertson, K. Hamilton, C. S. Sneyd, E. Baird, O. D. Johnston, G. Beecroft, L. Langlois.

BOTTOM ROW:—C. M. Bowyer, R. Laurie, G. F. Dean, B. Jennings, (Captain); G. Kay, L. Stokes, C. Catto.

ABSENT:—R. B. Kerr.

On the Second team, Kennedy and Willford were on the roll. Both these men showed their skill in senior company several times. Lyle Kennedy had the misfortune to suffer an injury to his face, but after a short rest he was back in the game. The intermediates although losing their group in the O. H. A., won the Intercollegiate.

Glad. Thompson, the quiet goallie, was School's only playing member on the 1st team. Beattie Ramsay and Gord. Duncan coached and managed the team to Intercollegiate champions. Owing to sickness, the team got away to a bad start in the O. H. A.

Gord. Duncan, after a hard rugby season and besides managing the Varsity 1st team, was one of the reliable players on Senior School's Jennings Cup team. We wish to thank not only the men that helped School as players, but also Glad. Thompson and Beattie Ramsay for their services as referees in the Interfaculty series.

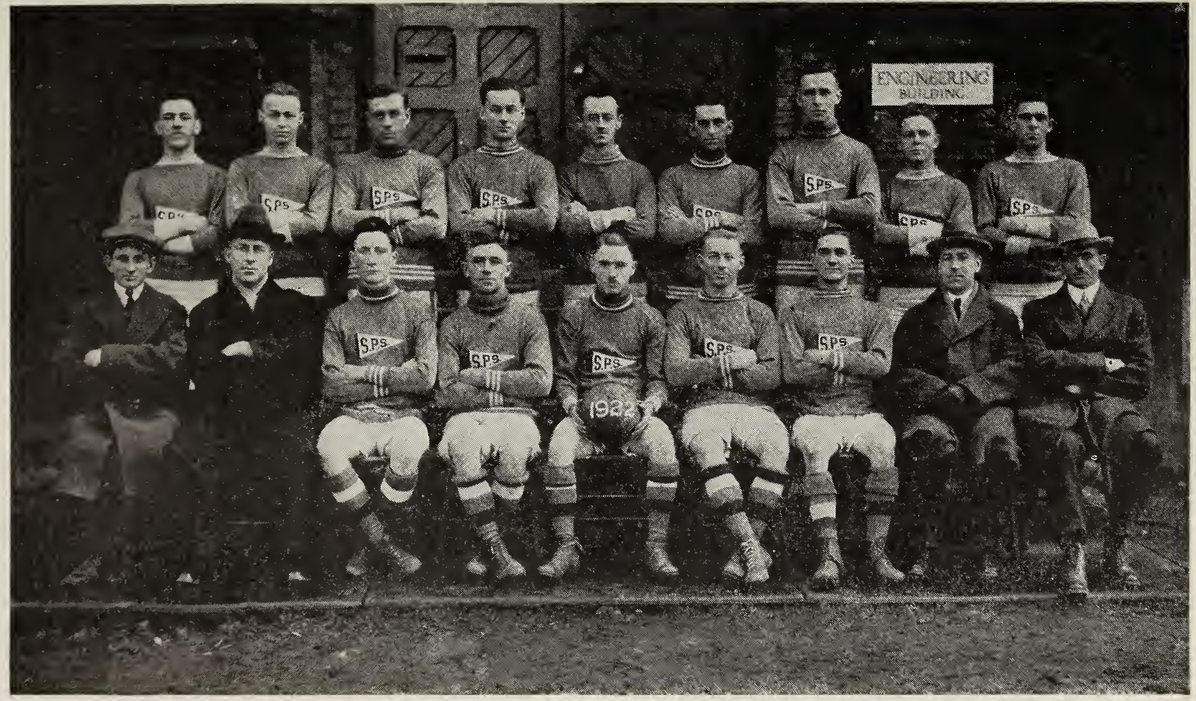
R. M. LAURIE.

# ASSOCIATION FOOTBALL

Football has had a big year around the University this season, and indications point to a revival of the Intercollegiate Series, which will bring the sport again to its position among the leaders in the athletic world. A most successful tour was undertaken last fall when the Varsity Firsts visited New York, Princeton, Lehigh and Philadelphia. The team won the first game from the well-known Crescent Club of Brooklyn by 7 goals to 0. From this victory they went straight to Princeton and defeated the U. S. Intercollegiate champions by 4 goals to 1. Lehigh University went down by 3 goals to 0 and the tour ended in a drawn game 1-1 with U. of Penn. team, giving three wins and a draw and a total of 15 goals for and only 2 against.

School was well represented on the team in the persons of Evans, Johnson, Smillie and Wingfield. To Evans goes the credit for the remarkably low number of goals scored against the team. They all not only did great credit to their faculty in their efforts in the sporting line, but judging from some snaps floating around School after the trip, they acquitted themselves very favorably in the eyes of the "Belles" on the bathing beach at Atlantic City.

Due to no Intercollegiate Series this year, School entered a team in the Interscholastic Series and landed the championship after some hard-fought games with Meds and Dents, and in the finals with Arts, who had beaten O. A. C. 9 goals to 8 on the round.



S.P.S. INTERSCHOLASTIC SOCCER CHAMPIONS.

TOP ROW:—G. B. Craigie, C. A. V. Armour, G. I. Wilkinson, R. A. Story, M. G. Evans, N. F. Johnston, C. H. Lucas (President); D. L. Melick, T. A. T. Legge.

BOTTOM ROW:—J. H. Browne (Secretary-Treasurer); Prof. J. T. King, (Hon. President); H. E. Wingfield, C. P. Breuls, W. R. Dunbar, (Capt.); J. MacLellan, G. D. Scott, Prof. E. A. Allcut, (Honorary Coach); L. D. Campbell, (Vice-President).

In the Interfaculty Series, School entered two teams, a Junior from the first and second years, and a Senior team from the third and fourth years. There was plenty of material to choose from, especially with the Juniors, who made an excellent showing and promised good for the future. The Seniors were defeated by Senior Dents for the group honors after a very close game, the Dents being later defeated by O. A. C. in the finals.

Soccer will be affected in the same way as all other sports by the passing out of 2T3, but the interest and support of these men will always be given for the sake of their alma mater.

It would not be fitting to close this report without making some mention of the valuable help and experience we have received from the two honorary members of the Club, Prof. Allcut and Prof. King. The former, as Hon.-Coach, has helped us not only in the selection of the teams, etc., but has also been responsible for drawing up a constitution for the Club which will make it much easier for the new executive, with Lorne Campbell as president, to cover the work next year.

The Club is also very grateful to the School Athletic Association in the way they have completely outfitted the two teams, and for their general support this year. It is this kind of co-operation between the Association and the various clubs of the faculty which boosts Interfaculty athletics.

The members of 2T3 wish the new executive and the Club the best of luck in the future, and, by the way, how about a game between 2T3 and School at the reunion next fall? Think it over.

C. H. LUCAS.

## TRACK

For the fourth successive year, School has captured the Toronto Cricket Club Cup and also the indoor championship. This is a very fine record and it should be the ambition of every school man to uphold and continue the good work.

Unfortunately we are losing several good men this year in "Art" Bell, G. Langford and Meredith and others, but with such men as Innes, Cade, Turner, Morrison, etc., to carry on, we should not be out in the cold.

Last fall we started a new idea in Track work when a very successful Interyear Meet was held, Monday, October 9th. The individual champion was "Art" Bell, who ran away with three firsts in the weight events. 2T3 won the year championship but 2T5 and 2T6 made very good showings and should put up a great fight next year for the championship.

On the following Friday, "Art" again towered above everybody else with the same three firsts and in these events either G. Langford or Bert Morris grabbed a place also. This, along with the good work of Cade, Innes, Meredith, Turner and others, gave us 50 points with Meds and Dents tied for second place with 24 points each.

S.P.S. TRACK
CHAMPIONS.

TOP ROW:—

J. G. Cade,
J. E. Buchan,
D. L. Polak,
R. K. Innes,
W. I. Turner,
G. B. Langford,
H. M. Morris,
A. A. Bell,
H. J. Meredith,
C. A. Morrison.

In the Indoor Meet, School again walked away with things, Evans coming within 1 point of being Individual Champion, with Cade, Morrison C. A. and Pollack running close behind.

Several records went by the board at this meet, among which were the Shot Put by "Art" Bell of 41 ft. On the same day, Morrison C. A. lowered the 220 record by 1/5 of a second to 24 3/5 seconds, and Turnbull made the Mile Walk in the remarkable time of 7 min. 29 3/5 sec., which was 22 2/5 seconds below the previous mark. Evans, 2T3, also tied the 50-yard record for the second successive year in the time of 5 4/5 seconds.

In the Intercollegiate Meet, Varsity did not do as well as was expected, but as usual, "Art" was on hand with two firsts, and the showing of our other representatives from School was very encouraging.

In closing, I would like to wish the members of the Track Club the best of success for the coming years and would like to appeal to some of our strong arm men to turn out next fall to replace the trio, Bell, Langford and Morris, who are leaving us this year. This is not only necessary for the School Team, but also applies to the Intercollegiate Team, which next year will have the best chance of copping the silverware that they have had in many years and on our own track too.

J. H. Browne, 2T3.

# THE BOXING, WRESTLING AND FENCING CLUB

It has been felt for several years that the Davidson Cup has been too much of a stranger at the "Old Red School." The reason for this is that the sports which this cup represents are not as well supported at S. P. S. as they should be. In a man's faculty, such as School, this state of affairs should not exist.

In order to encourage more interest in this branch of athletics, a School Boxing, Fencing and Wrestling Club was organized last fall. Bob Relyea was chosen as manager to show the boys how neatly it might be done with a right cross. C. L. Brittain, E. B. Hubbard and H. L. Norman were elected to instil the proper spirit in their several years. An Inter-year assault was arranged to secure new material. Men who had won a senior bout or a junior final were barred, so that beginners were under no handicap. A cup was put up which it is intended will be competed for each year.

This School meet was held Dec. 9th, and was successful in bringing out some promising material, besides providing many well-contested bouts. 2T5 won the cup by a good margin with a fine string of boxers and wrestlers.

The winners of these events represented School in the Junior Varsity Assault held a week later. The result was that School had a strong team and succeeded in winning the Junior Interfaculty Championship. This was gratifying considering the poor showing from lack of entries School made in the same contest last year.

In the boxing, Hubbard's performance in the 118 class was particularly good. Toye in the 135 class and Switzer in the 158 class won their finals. In the wrestling School met a doughty opponent in Dents and only took one final, the 175 class, which was won by Jeckell, who defeated his man without difficulty. In the fencing, Grenzeback won the final.

Most of the winners of these two events will be at School for two more years and during that time they have good opportunities of winning further honors for School in Senior events.

In the Assault in December between U. of T. and O. A. C., which the former won, School provided two of the boxers, Bob Relyea and Maguire, who were successful in winning their events.

When Varsity met West Point after Christmas, their boxers were represented in two of the weights by Schoolmen—Bob Relyea and Fred Seaborne—both of whom gave their opponents stiff opposition till the last bell.

In the Senior Interfaculty Assault, School made a strong effort to capture the Davidson Cup. However, this went to the Dents with School and O. A. C. tied for second place.

School's failure to land the prize lay in her lack of wrestling material. What we had was good but there was not enough of it. Before School can make sure of this cup, more wrestlers must be developed. None of the weights should go unchallenged by School. Alex Murray turned in a good performance in the 145 pound wrestling. In the 175 pound class, two Schoolmen contested for this place on the Intercollegiate team, W. H. D. Clark and Jeckell, a bout which Clark won.

In the boxing, Hubbard won the final in the 118 class. "Hub" has two more years at School and it looks as if he could be counted on for this class, not to mention picking off an Intercollegiate championship. He made a good show in trying for it this year.

Bob Relyea won the 125 from another Schoolman, Dave Lloyd. Dave is charging his loss to experience and intends to look after this class next year when Bob has graduated. Bob represented Varsity in the Intercollegiate and drew battlers both nights. He won his first and in the final his opponent's seconds wanted to throw in the sponge after the first round but the McGill boxer insisted on continuing and put up such a game exhibition that the judges gave him the decision.

The 135 class was well represented by School with three men in the semi-finals. Fred Seaborne was forced to withdraw through doctor's orders from the final, which went to another Schoolman—Maguire.

Fred graduates this year and with his departure not only School but Varsity will lose a capable man. Besides being a boxer of no mean prowess, his executive work in connection with the Varsity B. F. and W. Club, of which he has been President during the past year, has added much to its success.

The battle between School's super-heavyweight, George Langford, and Mahon, of St. Mike's, was the event of the Assault. It went four rounds with Mahon getting the decision on points.

A large number of the Varsity Inter-Collegiate team are graduating this year. Here is School's chance to step up and fill the vacancies in the ranks. There are now plenty of opportunities for the beginners to enter the game in the Junior meets and secure experience and confidence for the Senior events. School itself is losing several of its "old-timers" but the men who are left can be counted on to see that School maintains her traditional place—second to none.

W. S. Maguire, Pres. School B. F. & W. Club.

# SWIMMING

That swimming is one of the outstanding sports participated in by the men of S. P. S. is ably demonstrated by the water squad in their rigorous training and by the enthusiasm and support which they have received from School. 1922-1923 is the first year since the Fitzgerald Cup was donated for Interfaculty Swimming that it has not found a resting place in the Old Red School House. University College were returned winners over School by a margin of two points. Our relay team, consisting of Harston, Lindsay, Wells and Keefler, set a new record of 1.50 min., breaking the Interfaculty record by 3 2/5 secs. and the Intercollegiate by 2 1/5 secs. Harston won the 50 yards speed, Fitzgerald the 100 yards breast, and Keefler the 100 yards free style, tying Geo. Lindsay's record of 63 4/5 secs., so, although beaten, we were by no means disgraced.

On the Intercollegiate Swimming Team, School were as usual well represented. This year's meet was held in Hart House and was well attended. Varsity gave McGill the worst trimming they have ever received, the final score being 41 1/2 to 24 1/2. Vernot, of McGill, set several new records, the best of which was the time of 2 min. and 19 2/5 secs. for the 200 yards, in which event Wells swam third. Keefler was second to Vernot in the 50 yards free style, while Fitzgerald won the 100 yards breast stroke. The outstanding feature of the evening was a relay race, when the Varsity team, of which Keefler was a member, hung up a new record of 1 min. 46 secs. flat.

And so School's swimming activities are over for another year, which, although not as successful as others, has added yet another notch to the stick of things well done, but with the passing of 2T3 a gentle warning should go out to the rest of S. P. S. to look well to their laurels in the swimming game because School's teams in this sport have for the past four years been drawn from members of the present graduating year.

C. M. Wells, President U. of T. Swimming Club.

# WATER POLO

S. P. S. would have had little difficulty in renewing her triumph of the previous year when the Interfaculty series was won without a defeat, but that five men playing Intercollegiate polo were barred from playing with School. A new team had to be built up during the Rugby season when we missed such men as Booth, Kerr, Kingsmill and Murray. On the turnout of these men a decided improvement was noticed in School's game and we went through the rest of the schedule without a defeat; but it was too late as Junior U. C. had a strangle hold on the cup.

"Slim" Bell, Conklin, Fitzgerald, Harston and Wells played Intercollegiate Polo again this year and helped considerably in Varsity's 4-1 victory over McGill at Hart House. "Slim" Bell played a wonderful game in goal, while Conklin's work on defense was a treat to behold. McGill's 6-0 victory in Montreal gave them the round and with it the Polo championship for three years in succession.

The following fish took part in the University aquatic activities during the year:—Bell 2T3, Conklin 2T3, Fitzgerald 2T3, Harston 2T3, Wells 2T3, Schinbein 2T3, Murray 2T3, Keefler 2T4, Kerr 2T4, Kingsmill 2T4, Coleman 2T4, Hill 2T5, Booth 2T5, Little 2T5.

C. M. Wells, President U. of T. Swimming Club.

# BASKETBALL

In the past year basketball enjoyed a very successful season at School. School was represented on all the Varsity teams, Captains Duffill and McLean being two of the stars of the Firsts, while Bell and McBride were members of the Senior O. B. A. quintet. In addition to these there was enough talent left to win the Sifton Cup. The Junior School squad followed the example of the Junior School Rugby Team, and accomplished this feat.

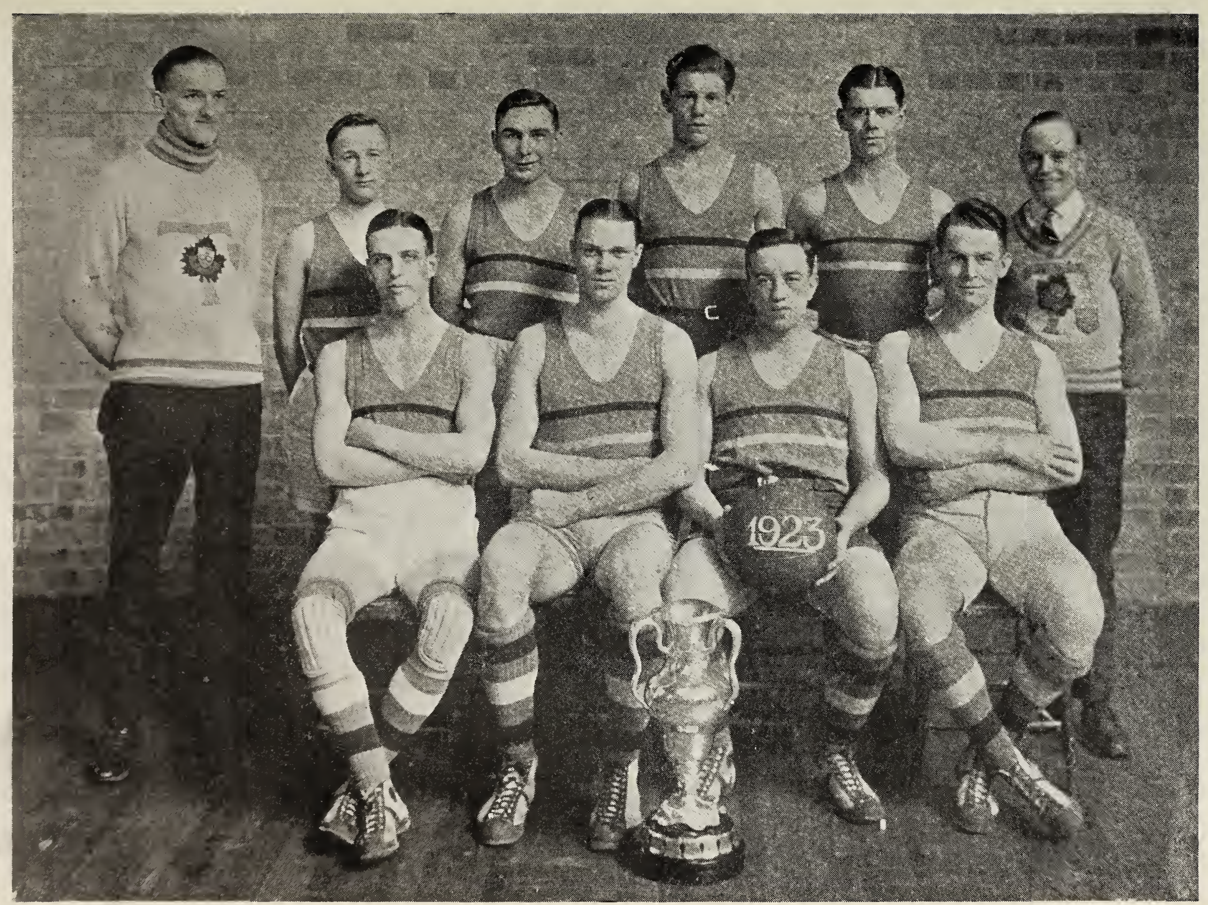
The Juniors were a fast, aggressive, well-balanced team who well deserved the championship. They won their group by defeating Knox and Trinity, Knox gave them their hardest battles but Trinity proved very weak, and in the second game School ran up the record score for this season and perhaps for all time. When the final whistle blew, Trinity was on the short end of a 62-0 score. In the second round, School was grouped with Sr. Vic and Jr. Dents. The Vic team was looked upon as the team to beat, but the Juniors defeated them rather badly in both games and dealt with Dents in a like manner. Sr. Dents were successful in winning their group in the second round and entered the finals against Jr. School. It was thought that the light School defence would have some difficulty in stopping the heavy Dent team but they came through with flying colours. The final score, 25-13 in favour of School, was a good indication of the play.

The team consisted of Little (Captain) forward, Loydd, forward, Dow, forward, Turner, centre, Patterson, defence, Buckland, defence, and Roelofson and Rogers, spares.

The Senior School team was not as successful as the Juniors, as they lost out in their group to Senior Vic. The first game resulted in a 16 to 9 win for Vic, and the second also ended with Vic on the long end of a 16 to 15 score. In both games School had an even share of the play but fell down badly in shooting.

Prospects for next year are very bright. Several of the Senior players are graduating but the majority of the Juniors will be with the Seniors if they do not make one of the Varsity teams. Each incoming first year seems to bring an ever increasing number of high class players, so both the Junior and Senior teams should be just as strong, if not stronger, next season.

W. B. Jennings, Pres. S.P.S. Basketball Club.



JUNIOR SCHOOL
BASKETBALL
TEAM, SIFTON CUP
WINNERS, 1922-1923.

TOP ROW:—

W. H. Duffill
(Coach);
F. H. Patterson,
G. S. Rogers,
F. L. Buckland,
F. L. Roelofson,
G. W. Smart (Mgr.).

BOTTOM ROW:—

W. G. Lloyd,
W. I. Turner,
E. M. Little,
D. W. Dow.

# ROWING

The 1922 season was really a most successful one. From the standpoint of trophies or championships, the Hanlan Memorial Trophy, emblematic of the Canadian 8-oar championship, was won for the third successive year. It is true many defeats were suffered by the different crews, but the most gratifying feature is the gradual increase in the number of members of the Rowing Club whose enthusiasm and devotion are unbounded and who will, as time goes on, form the backbone of a fine university club upholding the highest ideals of amateur sport.

By long hours of willing and persevering work much was accomplished. In the basement of the school building, under the able direction of Prof. Cockburn, an excellent working boat, the "J. Roy," was built entirely by the oarsmen and a few good friends. It has given and will continue to give first-class service.

The Parkdale Canoe Club most kindly allowed us to house our boats beside their clubhouse and all other accommodation was found in it. The Canoe Club members certainly were ideal hosts and great friendship grew between the two clubs.

The Rowing Club built a long shack for the shells and innumerable floats to launch from. Unfortunately, the shore there was very unprotected and the greatest obstacle to developing first-class crews was the rough water. Frequently rowing was impossible, and sometimes only by waiting till late in the evening was it possible to get out. Thus, for the final month, July, the three crews raced up and down the lake, each man cursing the folly of his predicament, at the same time unable to resist the lure of "another good ten."

The chief engineer and first mate of the coach boat, Kiota, were most faithful in their work and spent much of their summer holiday trying to make a balky engine stop balking.

The crews spent five days at St. Catharines for the Henley, which is becoming finer each year.

The senior crew went to Philadelphia the following week where they were again nosed out of the Championship of America.

This year the crews will row on the bay. A new boat is coming from England and an excellent squad is turning out.

Although winning trophies is gratifying, playing a game for the love of sport is the aim of sport. For this reason, the Varsity oarsmen are all sportsmen.

A. A. Bell.

# INDOOR BASEBALL CLUB

A School indoor baseball club was organized in the fall to co-ordinate the efforts of the two teams. The officers elected were: Hon. Pres., Prof. Treadgold; President, G. C. Mutch; Sec.-Treas, J. A. Williamson. Eric Taylor and Ray Sirrs were appointed managers of the Junior and Senior teams respectively.

For the third year in succession the Senior School team lost out to the eventual champions in a group play-off. Much enthusiasm was displayed throughout the season among the players, and all gave the best they had. The pitching of Gord. Mutch, and the catching of Dowe were the features of the play in all games. Ray Sirrs proved a most energetic and capable manager. The following men played in two or more games:

Bell, A. A.; Berner, T.; Brules, A.; Dowe, J. A.; Fitzgerald, A. M.; Fitzgerald, W. W.; Henderson, G. G.; Jennings, W. B.; McQueen, M. V.; Mutch, G. C.; Norman, R. M.; Williamson, J. A.

Junior School, after a hard fight, succumbed to St. Mikes in their group. However some good material was discovered for next year's campaign. Of the men who played in two games, seven were from the first year:

Agnew, R. J.; Bentley, W. A.; Burbank, E. F.; Burns, W. G.; Dickenson, F. R.; Leitch, K.; Little, E. M.; Lloyd, W. G.; Norman, H.; Peoren, J. E.; Teagle, R.; Smith, H.

We feel confident that next year will see School with a toe-hold and half-nelson on that old cup.

J. A. WILLIAMSON, Secretary.

# U. OF T. RIFLE ASSOCIATION

At the school night in Hart House this winter, a fourth year man was heard to remark that it was the first time he had known that Hart House boasted a rifle range. So perhaps a few words about the University of Toronto Rifle Association would be in place.

The Association was reorganized in 1919, and is now in its third post-war year. Previous to the war it was quite a flourishing association and School won the DeLury Shield, emblematic of the Interfaculty championship, the three years preceding the war. The total membership is now 120 and of that number School has 25. Dents lead in the matter of membership with U. C. of "Spark Plug" fame, third.

During the fall term, shooting was held daily at the Long Branch ranges and on November 11, the annual Interfaculty and Intercollegiate match took place. Dents won the DeLury shield again this year and Manitoba nosed out first in the Intercollegiate, with Varsity second.

In the winter term, practice was held four times weekly on the indoor range. There were three Intercollegiate matches. The complete scores for the third are not in from the other universities competing, but Varsity leads and the splendid score made at the last shoot make their chances look bright.

In a shoot between three picked teams of the C. O. T. C. and the Rifle Association, all three teams of the latter won.

J. D. WALKS.

# SQUASH

School's attitude toward squash has developed in much the same manner as the attitude toward spats. Both were at first regarded with suspicion as things outré and primarily designed for U. C. Then came tolerance, with some bolder spirits actually adopting the novelty. Now both are commonplace and going strong.

This year has seen a great increase in the number of Schoolmen playing squash. Perhaps fifty are actively interested in the game, the majority being in the senior years. Twenty per cent. of one of the larger departments in the graduating year play the game. So well has the University as a whole taken to squash that a court reservation for five o'clock is now precious beyond price.

School now holds second place on the permanent challenge board in the person of Steve Greey. Others listed are S. C. Scadding, E. W. Christman and V. D. Strickland.

In spite of the fact that the only hours free to Schoolmen are the most crowded hours at the squash courts, the game bids fair to increase in popularity. Inter-year or inter-departmental tournaments might well be run.

V. N. BRUCE.

# BILLIARDS

Well, fellows, it's not so good. Apparently the boys from the Red School House are losing their prowess as billiard players, or should we say, are not keeping up to the other fellow. Let's show them next year and bring back the championship that School has held for the past two years.

S.P.S. "T.'s."

TOP ROW:—M. Wolsey (Gym.); G. E. Lindsay (Swimming); C. M. Wells (Swimming); R. H. Keefler (Swimming).

CENTRE ROW:—W. H. Duffill (Basketball); C. H. Lucas (Soccer); W. I. Turner (Track); A. A. Bell (Track); J. C. Harston (Swimming).

BOTTOM ROW:—F. S. Seaborne (Boxing); R. C. Relyea (Boxing); G. W. Smart (Rowing); G. G. Duncan (Rugby); A. M. Fitzgerald (Swimming); H. E. Wingfield (Soccer); N. F. Johnston (Soccer); M. G. Evans (Soccer).

School had a numbers of men entered in the tournaments and some did exceptionally well for comers; H. E. Turner reaching the finals. Switzer, Mueller, Burbank, McKellop and a few others also did well but failed to lift the cup. W. T. A. Bell, last year's champion, fell down in the pinch. So much for this year.

Billiards are becoming more and more popular, so let us see two School men fight it out for the honours next year. Rumor has it that J. M. Dymond is taking special coaching in billiards, and is going to give them all a run. More power, Jack! Let's make it a big year and bring the silverware back.

As in previous years, School will be well represented on the Billiard Committee next year, Mueller, McKellop, Burbank and Bell, all holding down office.

W. T. A. Bell.

## CHESS

In this, as in so many other games of a more athletic nature, School has been active during the past year.

The Chess Club is an all-university club, and consists of both graduate and under-graduate members.

The executive for the present and next year is as follows:

1922-23

Honorary President—Dr. Rudolf.
President—J. P. Dandy, IV, U. C.
Secretary-Treasurer—J. D. Burbank, III, S. P. S.
Team Captain—C. H. Meader.

1923-24

Honorary President—Dr. Rudolf.
President—J. D. Burbank, III, S. P. S.
Secretary Treasurer—W. W. H. Coulter, II, S. P. S.
Team Captain—C. H. Meader.

In addition there are representatives for the various faculties. The representative for School was Mr. E. Cowan, 2T3. The 1923-24 executive was elected at the annual meeting, March 21, 1923, and will not take office until the first meeting in the Fall. The School representative for next year has not yet been appointed. However, School is fairly well represented on the executive, considering that Mr. Meader, the team captain, is an old School grad.

As regards the membership of the Chess Club, over half of the undergraduate members are School men. There is something about the game, which is purely one of calculation, that appeals to the mind of a School man who has such constant use for mathematics. This is one field in which, during the past year, our friends in the Medical have offered us no competition. Besides the regular members of the club, there are a considerable number of School men who frequent the chess room with the idea of playing chess.

The club challenged the Toronto Chess Club to a series of three matches to decide the possession of the Shenstone trophy, emblematic of the chess championship of Toronto, and, I believe, Ontario as well.

Varsity lost the first game, playing eight boards, 2 1-2 games to 5 1-2, won the second, 5 to 3, and lost the third, 3 1-2 to 4 1-2. The last match was very close; one of our players had a won game, but owing to a little careless play lost it and thus losing the match, series and shield.

School is always well represented on the various teams. This year of the four medals presented to those players in their graduating year who had played on any team for two years or more, three went to School men. They were respectively: C. E. Lewis, B. Shaffer and E. Cowan. G. I. Wilkinson, also in his graduating year, although he made a good showing, was not eligible, as he had only played for one season.

E. Cowan was runner-up for the University championship in 1920. B. Shaffer won the Championship in 1921. C. E. Lewis was runner-up in 1922 and has a good chance to win this year.

The School members last year issued a challenge to any faculty or the University as a unit, to form a team of six players to beat them. The challenge was published in Varsity and a match was played. The all-university team used graduate players and yet School using under graduate players entirely, won easily.

J. D. BURBANK.

## BALANCE SHEET
of
## THE UNIVERSITY OF TORONTO, ENGINEERING SOCIETY

### As of March 9th, 1923.

### ASSETS

| | | | |
|---|---|---|---|
| CURRENT | | | $7,274.96 |
| Cash | | $ 60.80 | |
| Bank (Current) | | 1,113.63 | |
| Bank (Savings) | | 1,002.63 | |
| Victory Bonds | | 2,000.00 | |
| Accounts Receivable | $412.45 | | |
| Less Reserve for Bad Debts | 281.65 | 130.80 | |
| Mdse. Inventory | | 2,967.10 | |
| | | $7,274.96 | |
| FIXED | | | 574.29 |
| Office Equipment | $624.29 | | |
| Less Reserve for Depreciation | 80.00 | $544.29 | |
| Smoking Room Furniture | 70.00 | | |
| Less Reserve for Depreciation | 40.00 | 30.00 | |
| | | $574.29 | |
| | | | $7,849.25 |

## UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
## LIABILITIES

### As of March 9th, 1923

| | | |
|---|---|---|
| CURRENT | | $2,653.01 |
| Accounts Payable | $2,653.01 | |
| | $2,653.01 | |
| LIABILITY TO ENGINEERING SOCIETY | | 5,196.24 |
| Capital Accounts | $5,190.72 | |
| By Unclaimed Dividends from 1922 | 16.00 | |
| | $5,206.72 | |
| Less Net Loss | 10.48 | |
| | $5,196.24 | |
| | | $7,849.25 |

## UNIVERSITY OF TORONTO, ENGINEERING SOCIETY
## TRADING ACCOUNT

### From April 1st, 1922—March 9th, 1923

| | | |
|---|---|---|
| Sales | | $13,889.45 |
| Mdse. Inventory, April 1st, 1922 | $ 2,600.00 | |
| Mdse. Purchases | 13,265.06 | |
| | 15,865.06 | |
| Less Inventory, March 9th, 1928 | 2,967.10 | |
| Mdse. Sold | 12,897.96 | |
| Gross Profit to Profit & Loss Account | 991.49 | |
| | $13,889.45 | $13,889.45 |

## PROFIT & LOSS ACCOUNT

### From April 1st, 1922—March 9th, 1923

| | |
|---|---|
| Salaries | $ 580.00 |
| Publications | 563.09 |
| General Expense | 864.54 |
| Alumni | 29.40 |
| Dance | 56.11 |
| Dinner | 67.05 |
| Orchestra | 43.00 |
| Grants to Clubs | 187.25 |
| Weekly Dance | 48.49 |
| Community Night | 179.75 |
| | $2,618.68 |
| By Gross Profit from Trading Account | $ 991.49 |
| " Fees | 1,494.00 |
| " Interest and Discount | 122.71 |
| | 2,608.20 |
| Net Loss | 10.48 |
| | $2,618.68 |

If the name Lyonde is on your photograph your friends will know you patronize Canada's leading photographer.—Toronto News.

Fredrick William Lyonde and His Sons, Photographers of Famous Men, 167 Yonge St. at Queen. The finest and best equipped studio on the American continent.

*Forsan et haec olim*
*meminisse juvabit*

Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO
ENGINEERING SOCIETY

Old Series Vol. 27 TORONTO, MAY., 1915 New Series Vol. X. No. 1

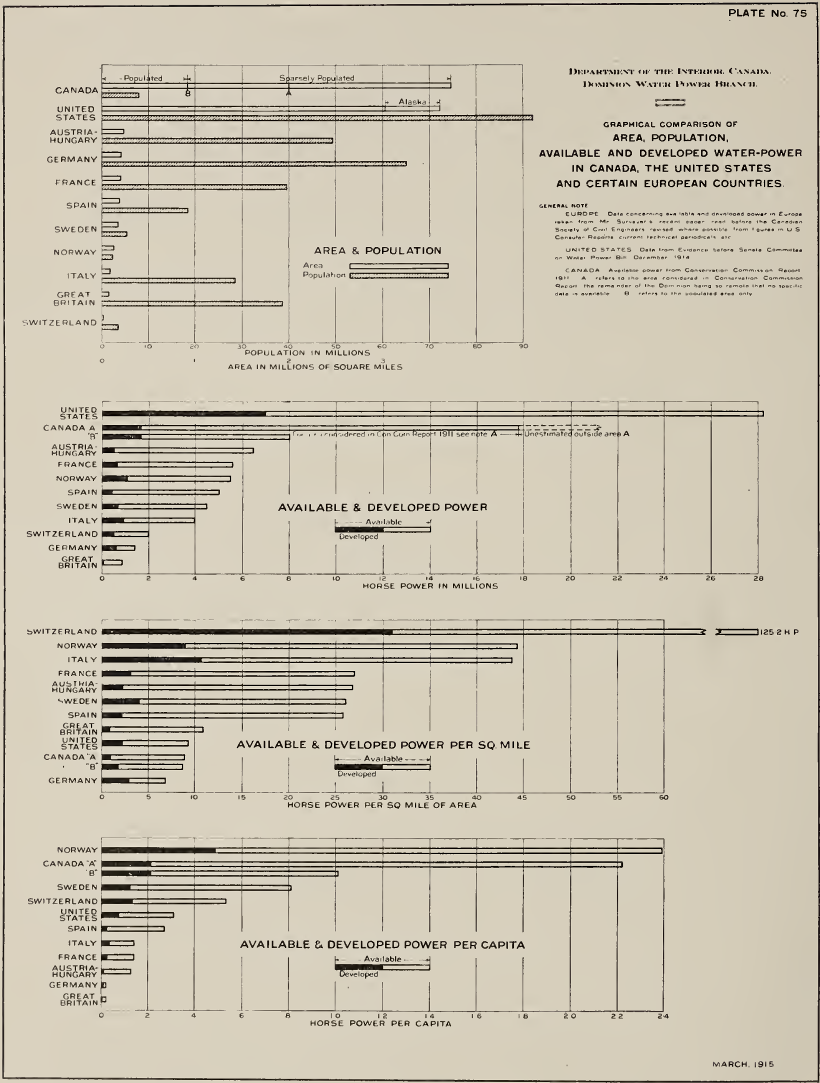
# THE WATER POWER SITUATION IN CANADA

## Exceedingly Advantageous Location of our Falls—Greatest Per Capita Development Except Norway—Greatest Total Available Except United States.

By J. B. Challies, '03, M. Can. Soc. C.E.
Superintendent, Dominion Water Power Branch

A survey of the water power situation in the different countries of the world shows that Canada, the youngest of them all, has accomplished more in actual development and in use, than any except, perhaps, Norway. The outstanding feature of the power situation in Canada is the exceedingly fortunate and advantageous location of our water powers from the Atlantic to the Pacific. Practically every large city is to-day supplied with all the hydro-electric energy it can use from water power, the sources of which can be extended to meet all anticipated demands. Where the source of power is not water power, as in the middle western prairies, there is an abundance of either gas or good steam coal within immediate reach. There is probably no part of the present settled portions of the Dominion where power cannot profitably be produced from wholly Canadian sources. In cases of necessity we can be, and in time we shall be, independent of all foreign power-producing agencies.

All substantial and reasonably necessary power requirements throughout Canada have been met and provided for, and much pioneer work has been accomplished in adapting hydro-electric energy to new and highly profitable industrial use. In fact, the water power situation strikingly demonstrates the faith of Canadians in our vast heritage. We have been extending an ever-widening net-work of transmission lines over our far-flung territories so that to-day, measured by population, we have the highest ratio of water horse-power of any other nation except Norway. On the other hand, as suggesting the room still left for expansion, we have the lowest ratio of water horsepower in proportion to area. The progress of power development in Canada has, so far, been based on sound engineering and sure economic principles, and there have, therefore, been very few financial failures. This has resulted in the



DEPARTMENT OF THE INTERIOR, CANADA.
DOMINION WATER POWER BRANCH.

GRAPHICAL COMPARISON OF
AREA, POPULATION,
AVAILABLE AND DEVELOPED WATER-POWER
IN CANADA, THE UNITED STATES
AND CERTAIN EUROPEAN COUNTRIES.

GENERAL NOTE

EUROPE Data concerning available and developed power in Europe taken from Mr Survayer's recent paper read before the Canadian Society of Civil Engineers revised where possible from figures in U S Consular Reports current technical periodicals etc

UNITED STATES Data from Evidence before Senate Committee on Water Power Bill December 1914

CANADA Available power from Conservation Commission Report 1911 A refers to the area considered in Conservation Commission Report the remainder of the Dominion being so remote that no specific data is available B refers to the populated area only

The Water Power Situation in Canada and other Countries popular delusion of the great potential value of undeveloped water powers, and in some districts in the general public being unduly apprehensive of the profits and powers of public utility corporations which control or develop existing water powers.

The great importance of our power resources, their successful adaptation for industrial use and for furnishing so much of our modern comfort, has resulted in the general public taking a very marked interest in all questions pertaining to water power administration, investigation and use, and the question of suitable legislation covering water power administration and authorization has become one of the most important legislative topics in Canada.

On the whole we are exceedingly fortunate in Canada, especially when we compare our conditions with those of the United States. Our water power laws are, in the main, quite adequate; encouraging to development with due regard to the public interest, present and future. While in some parts of Canada we may have outgrown former conditions and in such parts governmental machinery and laws with respect to water powers have not advanced as fast as might be desired, it must be remembered that there is but a short distance in time from the 50 h.p. overshot mill wheel of small efficiency and crude apparatus of local use and of little general importance to the community at large, to the 20,000 h.p. turbine of over 90 per cent. efficiency and 200 mile transmission line of to-day, of such widespread importance owing to the present universality of the electrical industry. In a very short time it is probable that legislators in all parts of the Dominion will have realized the advantage of and have put into force an efficient water power administration providing reasonable laws under which water power development will be fostered with due protection to the public interest.

In the lull which has temporarily supervened in power development in Canada, we can look back with satisfaction upon a long period of uninterrupted prosperity and marvellous expansion. This lull should enable the Dominion and Provincial Government Department, interested in water power matters to perfect their arrangements for securing that physical and economic data which is always essential and a necessary preliminary to the financing of new water power developments.

While in the past there has been a great lack of reliable data regarding Canadian water powers, there is now much excellent work under way throughout the Dominion which if continued and extended without delay, will result in sufficient data being obtained regarding all powers within transmission radius of present or prospective commercial centres being available for consideration when the present financial stringency is relieved.

It has been said that the use of power in Canada for electrochemistry, electro-metallurgy, and electro-siderurgy, has not kept pace with the advance made in these arts in other countries, and on the other hand that certain European countries are using about one-half of their developed water powers for these latter purposes. It must be admitted that most of the developed power in Canada is used for motive power, traction and lighting, and but a small percentage for electro-chemistry, electro-metallurgy, and electro-siderurgy. This condition of affairs is probably the result of a young country first, meeting its most urgent permanent and "primitive" power requirements, that is, for lighting, traction and motive purposes, and to temporarily postpone the extensive and intensive adaptation of power for electro-chemical and electro-metallurgical purposes; at any rate until adverse economic conditions and financial hazards surrounding the use of power for such purposes have been overcome. One thing certain, no country in the world has realized greater benefit from the advantages of hydro-electric power for domestic, municipal and manufacturing purposes, than have the people of the Province of Ontario, thanks to the Hydro-Electric Power Commission of Ontario.

In a general way any considerable extension to existing power plants and the development of additional water powers in Canada must depend primarily upon the demand for power from traction, lighting, and motive power sources, and but secondarily on the possible use of power for electro-chemical, electro-metallurgical, and electro-siderurgical purposes; of course the use of power for pulp-making alone excepted. Unless we use our power to supply the ever-increasing demand from our southern neighbors in the United States, the first use of power will grow directly with the increase in our population, slowly and steadily at any rate for the next decade. For any considerable increase in our present power demand, except power required for pulp-making, we must depend largely on proving the commercial possibilities of the use of power for electro-chemical and electro-metallurgical purposes.

## SHELL MANUFACTURE IN A GENERAL ENGINEERING PLANT*

**Perhaps the most fortunate of the various manufacturing institutions in its ability to readily take over the shell business is the general engineering plant. The equipment usually requires comparatively slight alteration, and there are also at hand the type of men and scope for designing and building any necessary special apparatus at short notice**

The unexpected change of employment of the greater number of Canada's metal working plants from the production of articles of peaceful commerce to the fabrication of munitions of war has been done at more or less sacrifice depending largely upon the character of the plant. The methods herein described for the manufacture of shrapnel shells are those adopted by a plant whose regular equipment is unusually well suited to the different processes involved. The product for which original machines were installed consists of internal combustion engines in large quantities, and it will be interesting to note the great similarity in the various operations required to those of the more warlike output at present being produced.

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* From Canadian Machinery, Toronto.

The shells are received at the plant from the steel works in the form of rough forgings. They are unloaded from the cars in a well equipped shipping department on to an auto-car operating on an industrial railway and by means of which they are transported to the shell department beside the machines which perform the first operation—the trimming of the open end. These include a cutting-off machine with two tools and variable feed, a John Hall & Sons Brantford pipe machine and a heavy standard lathe. The gauging point for this as well as subsequent operations is the bottom of the shell chamber inside.

## Use of Milling Machines

The basing or rough facing of the closed ends is done most efficiently upon an Ingersoll four-spindle milling machine, using the two vertical spindle heads. The plates of the machine carries four fixtures located in pairs near either end. These fixtures hold twelve shells each, arranged in two rows of six. The shell is simply dropped over a vertical gauge pin and is clamped, two shells to a clamp in an upright position.

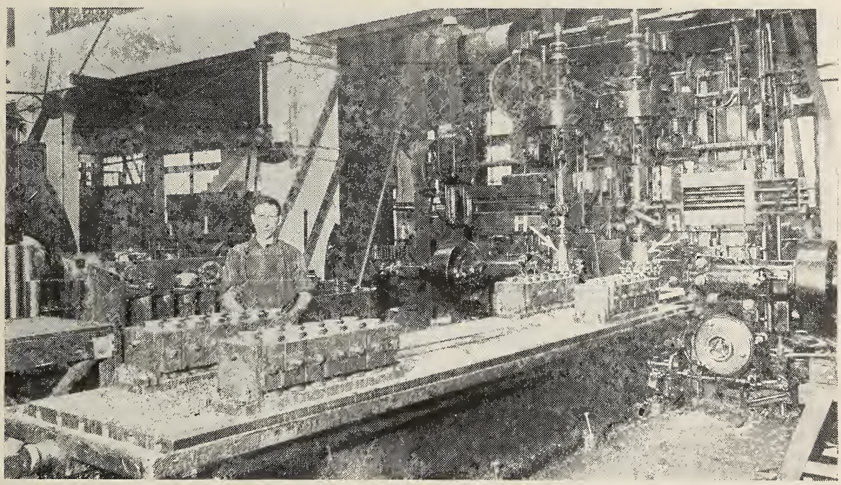

Fig. 1. Continuous Milling of Bases on Ingersoll Multiple Spindle Machine

The milling is done by two large, inserted tooth high speed steel facing cutters, one traversing each fixture. While one pair of fixtures is under the cutters, the operator is engaged, at the other end of the table, in emptying and reloading the other pair of fixtures so that the milling process is practically continuous. This has proved a most satisfactory method of doing this part of the work as the machine is powerful and rigid enough to work the high speed steel cutters to their capacity. Another machine of this type is being fitted up and will be in operation shortly.

After gauging for length, the forgings go to the various machines utilized for the outside turning. For this purpose the shells are driven upon mandrels solidly attached to the face plates of the machines. These arbors are solid and are fitted, upon the shank part, with a circular nut. When it is desired to remove the work, this nut is simply tightened against it and a tap with a hammer upon the side serves to release it instantly.

The turning is done on two Bertram and two Bullard vertical turning and boring mills, one Conradson turret lathe, one Gisholt, two heavy Steinle turret lathes and one Pratt & Whitney turret lathe. The Steinle machines are equipped with a special expanding arbor and are used to turn such shell forgings as come slightly large so that they cannot be tightly driven on the solid arbors. The gripping points consist of twelve pins in four circles of three each which are moved outwards against the shell chamber by the wedge action of the spindle which is actuated by a nut at the rear end.

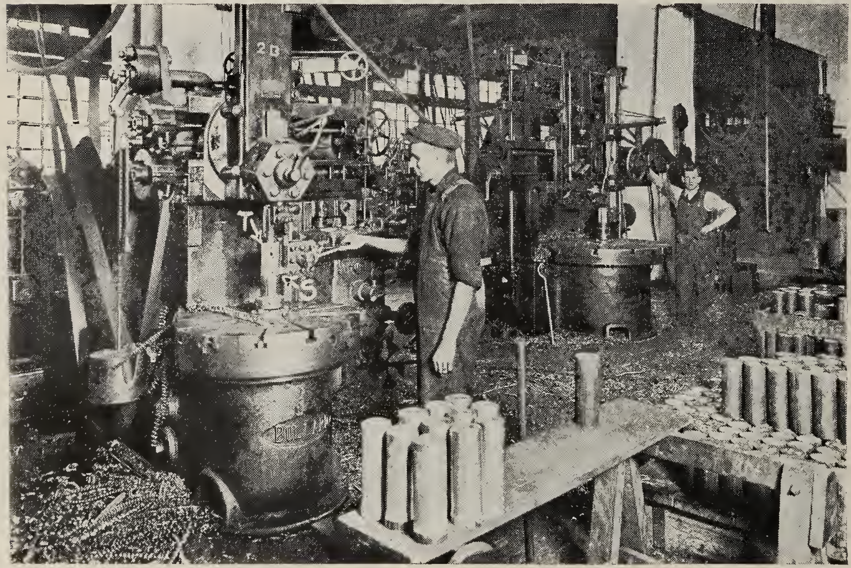

Fig. 2. Rough Turning Shell Forgings on Bullard and Bertram Vertical Turrets

It is interesting to note that, in quantity of production, the competition between the several machines is rather close, the Steinles coming first, the Pratt & Whitney second and the vertical boring mills third, although the difference does not amount to more than from six to a dozen per day.

The series of operations consists of rough turning the shell body, finish turning from the band to the base, finish facing the base and roughing out the groove for the band. The work on the groove here consists of cutting down the whole width to the top of the vees of the wave and of cutting down the two edges to the bottom of the vees. The rough turning of the body is carried up to the edge of the part which is nosed in, or, in other words, it involves the cylindrical part of the shell.

## BORING PROCESSES

The next operation consists in boring the shell in the bottom to receive the powder cup and also for the seat of the steel diaphragm which separates the powder from the bullets. This is also carried out on a number of machines of a widely varying nature. These include a Conradson turret lathe, a four-spindle Foote-Burt drilling machine, a Bertram horizontal boring machine, and others. At first sight, the latter machine appears extremely clumsy, and heavy for such work, but such has not actually proved to be the case. The rigidity of the machine and the abundance of driving power make up for a great amount of inconvenience and, what was at first a mere attempt to get something out of the machine and to keep it going has proved to be one of the best single spindles on the job, an output of 90 shells being obtained per eleven hours.

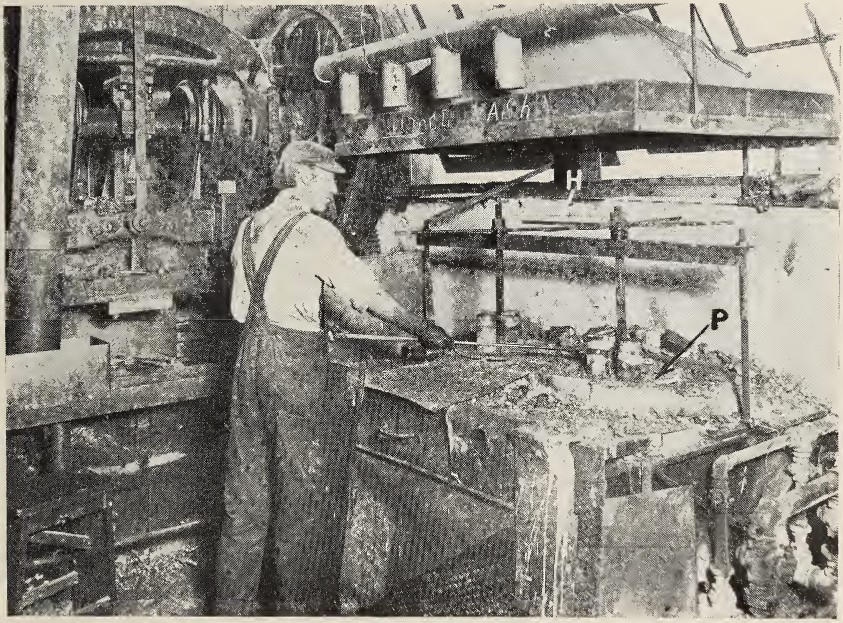

Fig. 3. Nose-heating Furnace and Nosing Press

The multiple spindle drill, while being a very satisfactory machine in point of simplicity of operation and quantity of output, cannot be readily arranged to do the facing of the end; this, however, is done on a small machine not large enough to do the boring. The boring tools used consist of two solid bars equipped with flat formed cutters, one for roughing and one for finishing. These cutters or bits possess the advantage of being easily made in numbers, and dull cutters can be quickly replaced by sharp ones without materially interfering with the progress of the work. The Foote-Burt machine operates two roughing and two finishing spindles continuously and is handled by two men.

The next operation is that of waving. This consists of turning in the bottom of the groove for the copper band a pair of inverted vees to prevent the band from turning on the shell as it traverses the length of the gun, so called because the vees are cut, not on a flat but on an undulating plane. The waving is accomplished by a square nosed tool with two vees of the correct dimensions cut in the face of it.

An interesting tool making question here arises as in order that the angle of the vee be correct on the sloping parts of the wave, the angle of the groove in the tool must be greater. The lateral oscillating motion is given to the tool by a face cam fastened to the face plate of the lathe. The work is done on two R. McDougall and two Bertram geared head lathes, equipped with special centering chucks which grip the work by the turned body. The cam roller is fastened rigidly to the lathe carriage and is held to the face of the cam by a suitable weight. After waving, the open ends are turned for heading on a small lathe by hand feed the purpose being simply to true up this part of the shell, and only enough is taken off to accomplish this.

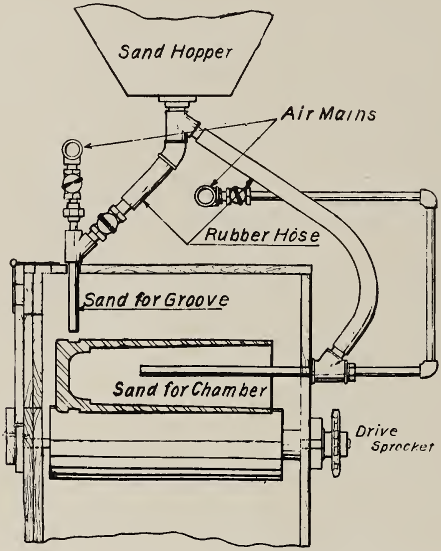

Fig. 4. Detail of Sand Blasting Machine

## HEAT TREATMENT

The shells come to this department placed on end in large trays, open ends up, each tray holding 120. A boy now paints the bases and grooves of the shells with a mixture of whiting and alcohol to prevent oxidation of the finished parts during heating, and returns them to the tray closed ends up. For heating the shells, six lead baths are employed, the warming and final heating taking place in separate baths. These pots are heated by oil burners and the temperature regulation is maintained by electric pyrometers. The work is heated for about half its length, and, to accomplish this, it is held in a vertical position by the circular cover plate of the bath which contains four suitable perforations to receive the shells which are held down by a conveniently placed weight.

The hardening is accomplished by dipping in oil, three tanks approximately 4 ft. by 2½ ft. by 2 ft. being used. The dipping is done with the open end of the shell entering the oil at an angle of about 45 degrees and is quickly reversed so that the base turns downwards. After chilling the shells are inverted upon hooks placed at the back of the tank to drain and are subsequently removed, cleaned and tested for hardness. For this, the well known scleroscope is used. The test must be applied at a specified distance from the end of the shell and at least three points in its circumference. A feature of the use of the scleroscope for this work is the rapid wear of the bulbs. Unless the very best quality is obtained these wear out at the rate of about one per day.

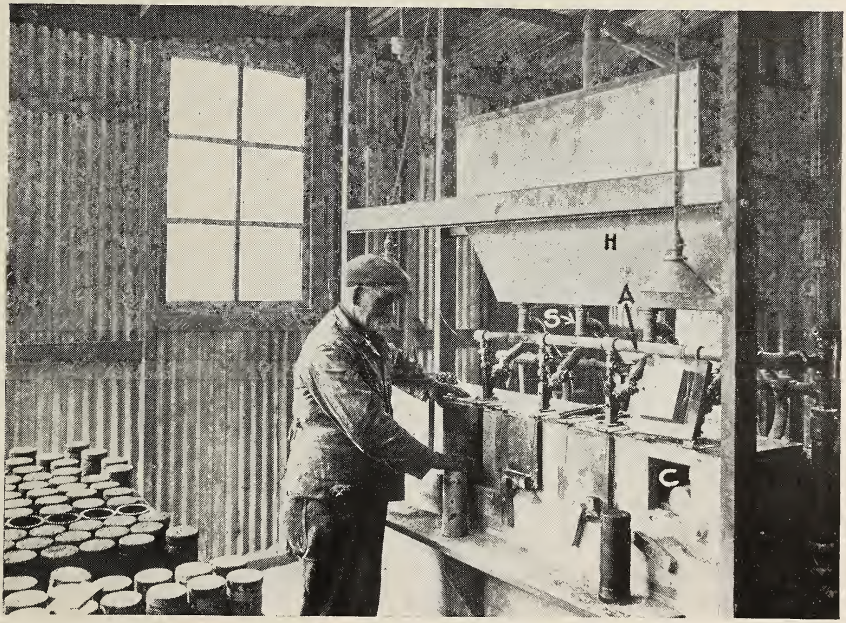

Fig. 5. Sand Blasting Machine which cleans Powder Chamber and Band Groove

The next step in the process is sand blasting the groove and the inside or powder chamber. This is accomplished by means of a very simple and most ingenious machine, devised and built by the Canadian Fairbanks-Morse Co. The apparatus consists of four compartments each just large enough to accommodate a shell and is closed by a wooden door. The shell rests upon a pair of live rollers so that it rotates continuously. One nozzle enters the open end and directs its flow of sand at the internal surfaces to be cleaned while another in a vertical position cleans the groove and its undercutting. There are, of course, four pairs of nozzles and the process is completed as fast as one man can handle the shells.

The forming of the nose is done on a heavy geared stamping and forming press. The furnaces used here are worthy of note. These are the usual oil heated lead baths covered with circular plates containing four openings to hold shells in the proper vertical position. The plates are connected to vertical spindles provided with four arms at the top so that, as a hot shell is removed and replaced by a cold one, the disc plate can be rotated a quarter turn to bring a fresh hot shell into position for the press man. The shells after nosing are allowed to cool slowly.

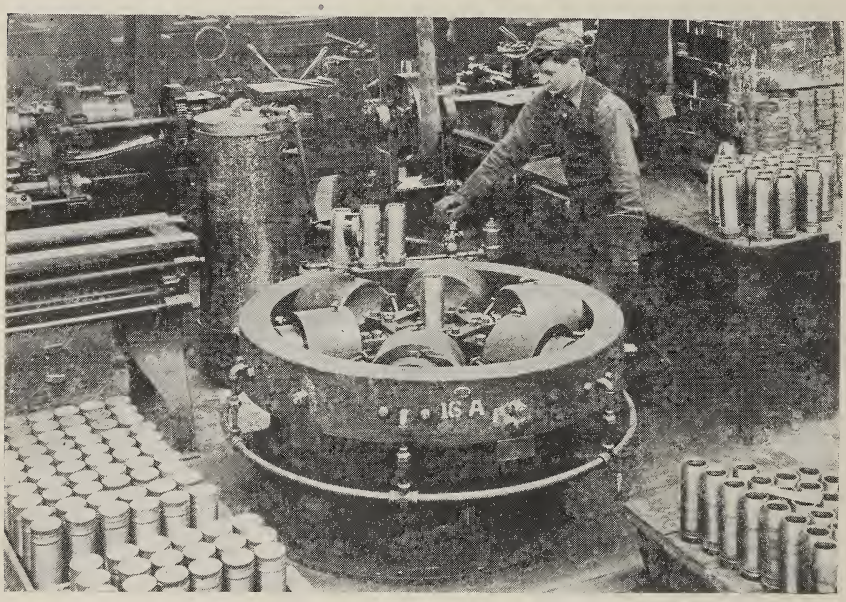

Fig. 6. Canadian Fairbanks-Morse Branding Press

The final operation on the base of the shell consists of cleaning and polishing on a rag wheel to remove all signs of the heating operations. The machining of the nose constitutes another series of operations, the first of which is the rough turning of the outside. This is accomplished by means of a plate carrying a cam slot and attached rigidly to the bed of the machine. This slot effectively guides the cam roller which is rigidly connected to the lathe cross slide and thus restricts the motion of the tool so as to give the correct contour to the shell nose.

The roller is held securely to the guiding face by weights and the feed of the tool is regulated by stops, a solid plate gauge being used to test for size over all. The nose is bored in the same way after grinding with an ordinary diamond point tool held in a short stout boring bar. The lathe carriage is guided in a cross-wise direction by means of a cam attached to the rear of the lathe bed as before.

The finish facing and tapping are done by turret lathes, a solid tap being used which is backed out by reversing the lathe spindle. The shells are now ready for grinding for which three Norton grinders are used The finishing of the shells by grinding is considered a success in every way by the management of this plant and they have deviated but little in their methods from standard practice.

The shells are centred by chucking at the rear end and by means of a plug carrying the centre at the front end. The machine is traversed in the usual way in grinding the cylindrical part of the work and a formed wheel is used only to finish the profile of the nose. Two plain grinders and one formed wheel grinder handle the output of the plant. The diamond problem is overcome by avoiding, as much as possible, wide formed wheels and the men in charge express themselves as well satisfied with the results. Following the grinding, the inside of the nose is turned to size and the shells receive their preliminary shop inspection in which particular attention is given to the undercutting and waving in the groove for the band. After this the shells receive their first government inspection which follows somewhat similar lines to the shop inspection.

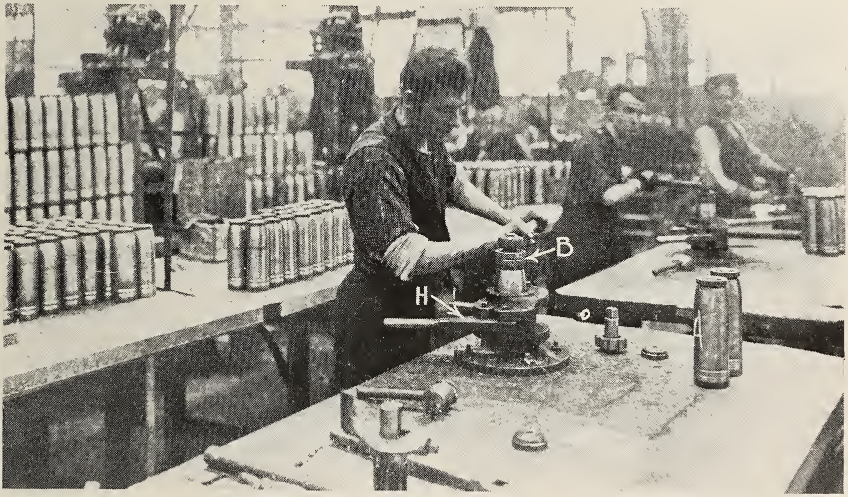

Fig. 7. Shell Vise and Ball-bearing Plug for Screwing Down Socket

## Banding Operations

The work in connection with the copper rotating band consists of a series of operations. The marking is done at this point upon a Holden-Morgan marking machine and the bands are crimped in place by means of a hand lever press which sets it down into the groove at four points in the circumference. The banding press is of the hydraulic six-cylinder type, built by the Canadian Fairbanks-Morse Co. So successful has this press been that the company has undertaken its manufacture, and has sold a considerable number to other people engaged in the shell business. The machine is operated by a belt-driven pump, and has a number of interesting features. The shell is placed, open end uppermost upon a small plate at the centre with the pistons working radially towards it, and the band is pressed home in two operations between which the shell is given an eighth of a turn so that the entire circumference is affected. The press is quick acting and the entire operation requires less than one minute.

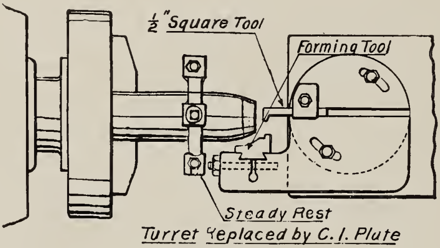

Fig. 8. Fox Turret Lathe with Turret Replaced by Set-up for Finishing Sockets

The turning of the band is done on small lathes using flat formed tools. The main tool is situated on the carriage in the usual place, while a smaller tool located in the centre of the carriage, so as to operate on the bottom of the work when the cross feed is reversed, is used to turn the flat parts of the band. A brass plate which acts as a rest for a hand tool is now slipped over the main forming tool and all burrs and ragged edges are removed from the turned band in this way.

## Assembly

The case of the shrapnel may now be considered finished and only requires assembling with the interior parts. These consist of the tin powder cup, the diaphragm, a brass tube leading down through the centre and which screws into the diaphragm, the bullets and rosin matrix, the cap and plug, and several bits of muslin solder, etc. The first operation consists of placing the tin powder cup beneath the steel diaphragm which was placed in the shell previous to the nosing operation. The tubes are now screwed in place and a felt plug upon the end of a wire is inserted to prevent all particles of material or foreign matter from entering the tube or the powder

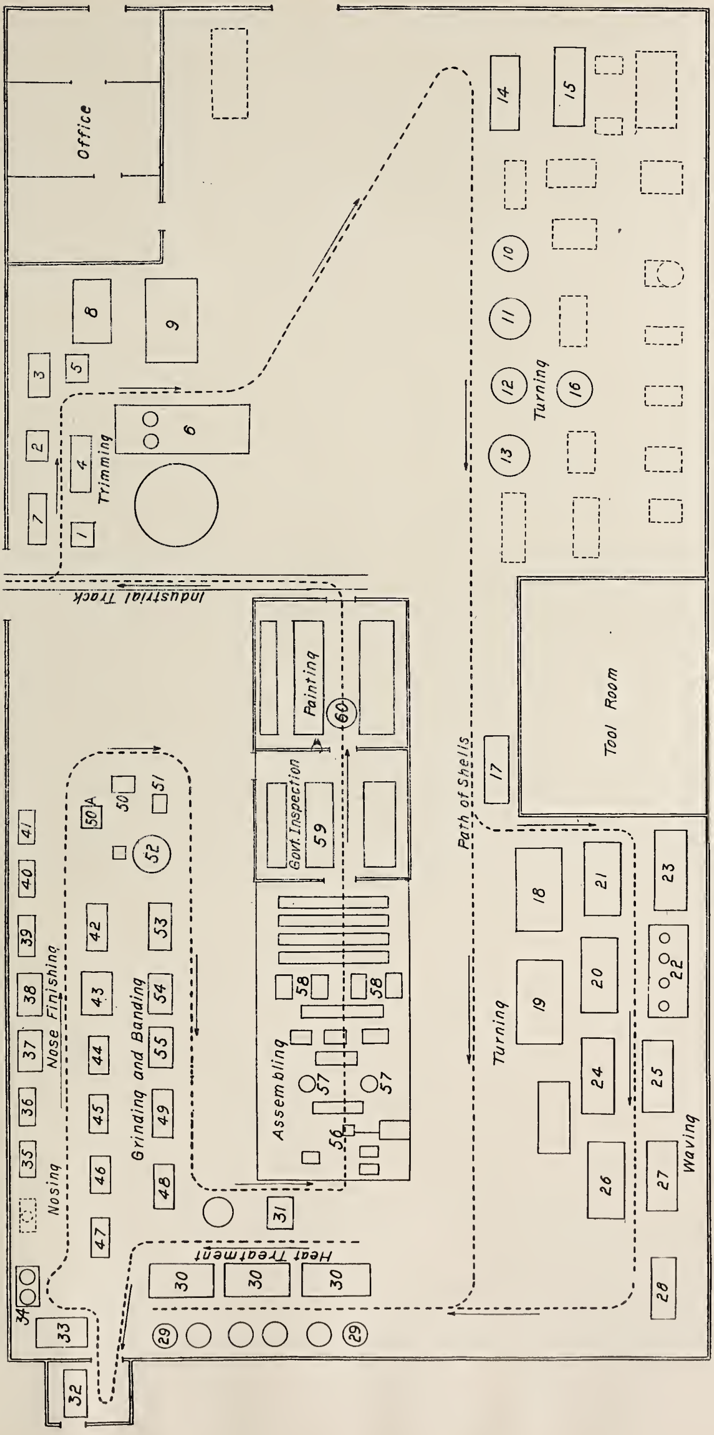

Fig. 9. General Layout of Plant Illustrating Path of Product and a Most Efficient System

SEE NEXT PAGE

case. This stopper remains in place until the completion of the assembly.

The bullets are stocked above on the gallery of the shop and come down to a filling trough by gravity through a tube in the same way that the diaphragm discs come down to the nosing press. This saves a considerable amount of floor space at points in the plant which are of necessity very much congested. The spout delivers to a trough at the end of which is a filling device especially designed to deliver the bullets to the shell in a steady stream rather than in a mass. It has been the experience of the officials of this plant that this is a most important point as the space cannot be perfectly filled by the bullets if these be dumped in bodily.

To insure the bullets being thoroughly packed, the shell rests

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GENERAL LAYOUT OF PLANT ILLUSTRATING PATH OF PRODUCT AND A MOST EFFICIENT SYSTEM

### Trimming

1—Pipe machine.
2—Rogers bolt cutter.
3—Bertram lathe.
4—Niles lathe.
5—Hall bolt cutter.
6—Ingersoll miller.
7—Bertram lathe.
8—Ingersoll miller.
9—Double spindle boring machine.

### Boring

14—Horizontal boring mill.
15—Horizontal boring mill.
21—Conradson turret.
22—Foote-Burt 4-spindle drill.

### Waving

24—American lathe.
25—Bertram lathe.
26—American lathe.
27—Bertram lathe.

### Turning

10—Bullard mill.
11—Bertram mill.
12—Bullard mill.
13—Bertram mill.
16—Bertram mill.
17—American turret.
18—Steinle turret.
19—Steinle turret.
20—Pratt & Whitney turret.
23—Gisholt lathe.
28—Small lathe—turn for nosing.

### Heat Treatment

29—Six Fairbanks-Morse oil furnaces.
30—Three oil tanks.
31—Scleroscope.
32—Fairbanks-Morse sand blast machine.
33—Nosing press.
34—Fairbanks-Morse furnace.

### Finish Nose

35—Lathe, tap and face.
36—Lathe, tap and face.
45—Lathe, tap.
46—Lathe, turn profile.
47—Lathe, turn profile.
48—Lathe, turn profile.

### Grinding

37—Norton grinder—grind body.
38—Norton grinder—grind body.
43—Norton grinder—grind body.
44—Norton grinder—grind profile.
39—Lathe, bore nose profile.
40—Lathe, bore nose profile.
41—Lathe, file profile when necessary.
50—Marking machine.
50A—Washing machine.

### Banding

51—F.-M. hand press—set band.
52—Fairbanks-Morse banding press.
53—Small lathe—turn band.
54—Small lathe—turn band.
55—Small lathe—turn band.
49—Small lathe—turn band.

### Assembling

56—Bullet spout.
57—Rosin pots.
58—Four Fox-turret lathes, turn socket.
59—Inspection benches.
60—Fairbanks-Morse painting machine.

during the process upon a vibrator plate which vibrator is very similar to that used on matched plate moulding machines. Short, rapid motion has been found to give better results than a longer and slower motion. The correct number of bullets is ascertained by weighing after which the shells go to the rosin pots. The bullets are not heated as is done in many plants, this being considered unnecessary if due care be exercised in the pouring of the rosin and in maintaining it at the proper temperature. Experience and the making of sections of a number of finished shells have amply borne out this practice in a very satisfactory manner.

After filling, the shells are again corrected for weight and are ready for screwing in the sockets. For this purpose, the case is firmly held in an upright position by a special vise operated by a lever and cam. The threads and seating parts of the socket are first luted with shellac and then screwed home by means of a special ball-bearing driver and a large, single-ended tap wrench. The plug used for this purpose is a very simple and efficient affair. It consists of the squared shank and a straight, threaded portion of the same diameter and pitch as the inside threaded part of the sockets. Upon the upper part of the thread are two hardened steel nuts fitted with grooves on their adjacent sides to form the raceway for a ball bearing B. The bottom nut seats against the socket to be screwed in and is jammed by the upper nut on account of the much greater friction in the thread bearing than in the ball bearing. For the same reason, the backing of the wrench instantly releases the plug from the socket from which it can be unscrewed by hand.

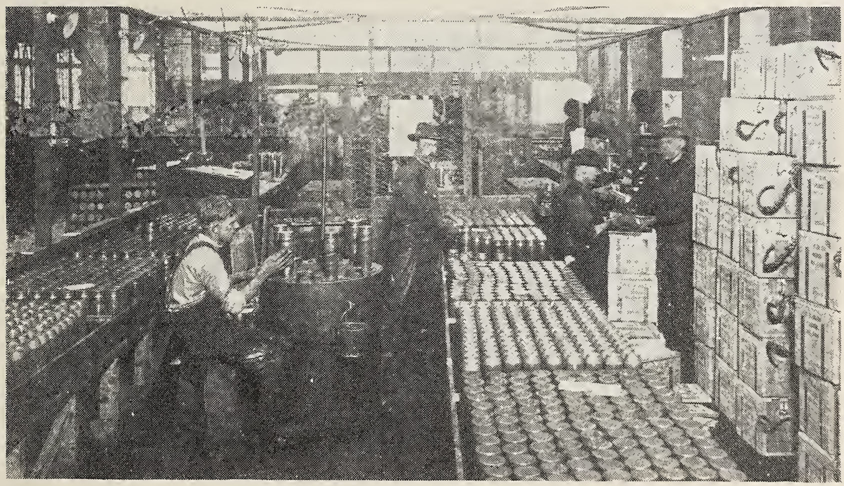

Fig. 10. Painting, Final Inspection and Crating

The tube is soldered to the socket by means of a special copper formed in the shape of a ring of the right size and provided with a groove on one side to allow the escape of air. The solder is used in the form of wire which is first coiled and then cut into rings, no acid being permitted in the process.

Finishing the outside of the socket in conformity with the general contour of the shell nose is done on four small lathes equipped with formed tools and steady rests. These lathes remove all surplus solder and in doing this perform the last manufacturing operation upon the shells. The latter now receive their final shop inspection and are passed on to the officials of the government for their final gauging and inspection. Upon their being passed and the receipt of favorable report from the firing test, the shells are painted to prevent deterioration by weather conditions.

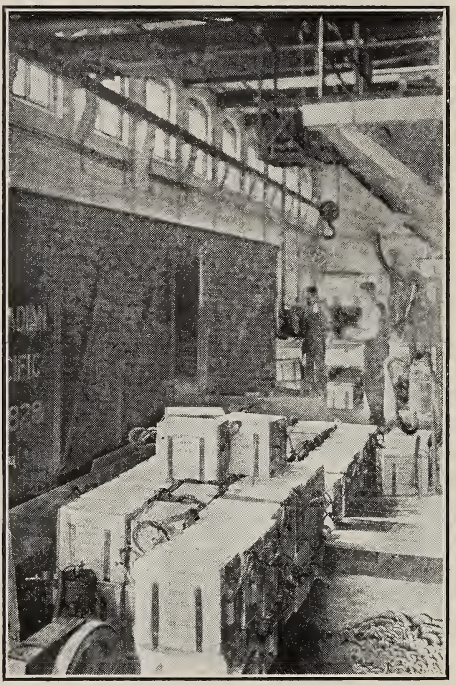

Fig. 11. Shipping and Receiving Department—Loaded Industrial Motor Car.

### TESTS

It will be remembered that, at the preliminary inspection, two were chosen from each series of 120, one of which was to be prepared and sent to the arsenal for the firing proof and, from the other, a section is to be cut out as designated by the inspector for the preparation of a specimen for the tensile test of the steel. The shells are painted on a very ingenious machine designed and built by the Canadian Fairbanks-Morse Co. This machine, like the banding press, is being constructed in numbers and sold to other shell manufacturers. It contains six vertical spindles spaced evenly about a flat circular table. These spindles are kept in constant rotation at a speed of about 250 r.p.m., by a motor at the base and which receives its current through a lamp socket from the ceiling. The shells are placed in an inverted position upon the upper ends of the spindles, the friction being amply sufficient to drive them with the necessary force. The painting is done with a flat pad from paint receptacles conveniently attached to the machine. The table revolves upon ball bearings and the whole is on wheels so that it can be readily moved to the work. The time required for the painting is one minute per shell for the three coats as specified by the government.

The shells are removed from the machine with a special holder that grips them by the copper band and are placed in racks to dry. After the painting is completed, the shells are finally inspected and packed in wooden cases holding six each. These are loaded upon an industrial railway car and taken to the shipping department whence after inspection of the cases, they are loaded into railway cars two tiers high and start upon their long journey to France, and after loading with the powder charge and primer, to the battle fields.

## System a Factor

The most striking point in connection with this plant is the evident perfection of the system employed. From the moment the forgings reach the plant, not a backward movement is made. The flow of shells through the plant is smooth and uninterrupted and at no point do the streams cross over. The result of this is evident. Foremen and superintendents are conspicuous by their absence in the shop and are to be found in the office attending to business.

The transfer truck and pyramid system is used almost entirely and the shells are unloaded upon the floor only where absolutely necessary. Another striking feature is the utilization of all the machinery of the plant, both great and small, the devices to this end being in many cases original.

The company has bought little, if any, outside machinery. On the contrary, the special machines required have been designed and built within the plant and many have been sold to outsiders. The co-operation of Canadian manufacturers in assisting each other in this and in other ways has not only been the surprise of the business to foreign companies, but has been, perhaps, the greatest factor in the successful handling of this great work by Canadian financiers and manufacturers.

# A SOUTHERN BRITISH COLUMBIA POWER SYSTEM

By Vincent S. Goodeve, '10

Many people in the Eastern provinces of our Dominion are inclined to regard British Columbia as a comparatively new and undeveloped province. Yet, as far back as 1897 gold and copper mining and smelting had reached such a stage as to cause far-seeing men to begin the construction of a hydraulic power plant to supply the promised market. I refer to the West Kootenay Power & Light Co., from whose system nearly all of the mining and smelting industries of what is known as the Kootenay and Boundary countries, are supplied with power. Much of the ore in these districts is of such low grade as to require a good supply of cheap power in order that the ore may be handled in sufficient quantities to render its mining and smelting profitable.

In 1908 the company were supplying power from their first plant situated at Lower Bonnington Falls on the Kootenay River about ten miles from Nelson. The available load at that time was 1,000 h.p. at the end of a 32 mile transmission line. That the venture of the company was justified is evidenced by the fact that this original plant of 4,000 h.p. capacity is now used as a stand-by while their second plant at Upper Bonnington Falls, about one mile from the first and of 16,000 h.p. capacity, together with No. 3 plant at Cascade City on the Kettle River and of 3,900 h.p. capacity, are required to supply the present load. No. 2 plant was completed in 1907, and in the same year the company took over the system of the Cascade Water, Power and Light Co., including what is now the No. 3 plant, which was supplying power in the Boundary country but which had not the capacity to supply the increasing demand. Forthwith, the Bonnington power was extended into this country and arrangements made whereby either source may be utilised to supply a limited supply of power to the other system in the event of a breakdown or shutdown for any cause.

The transmission voltages and places supplied from the various plants are as follows:—

No. 1 plant—Dead, and its customers supplied by special transformer in No. 2 plant, transmitted at 22,000 volts to Rossland, Trail and Silver King Mine.

No. 2 plant—60,000 volts supplied to Rossland, Grand Forks, Phoenix, and Greenwood.

No. 3 plant—22,000 volts, supplied to Grand Forks, Phoenix, Greenwood and Boundary Falls.

All current is transmitted at 60 cycles and stepped down to the prevailing distribution voltage, usually 2,200 volts, at the various substations.

Someone has rightly said that if the province of British Columbia were flattened out it would have twice its present area. The building of a transmission line in such a country is not an easy task. The power must go wherever the mines and smelters are located. The smelters must be built wherever the character of the land and the railroad facilities will permit. These conditions lead the power lines over rough land to altitudes of six thousand feet and down again to two thousand feet. The patroling and repairing of such a line is an expensive matter, and the company found it better to build a line requiring very little attention but costing more than the flimsier line. The 60,000 volt line is a model in this respect and its 84 miles of duplex three phase line give remarkably little trouble. It is also remarkably straight considering the character of the country through which it passes. The heavy cedar poles are spaced only from 100 to 150 feet apart. The cross arms are heavy and the butts are often placed in blasted holes in solid rock. Only a few freak poles have shown signs of decay as yet, and only once or twice has the lightning been known to set fire to the pole or cross-arm. The line is not sectionalised. One line can carry all the load, so that as soon as trouble is found to be on either line, the entire load is thrown on the good line. Being on separate poles, trouble on one line does not cripple the other. So amply has the system been designed that it has not been found necessary to transmit at the rated voltage as yet, but current is transmitted at 40,000 volts by using taps in the windings of the transformers at the generating and receiving stations. This causes a saving in the expenses of locating and replacing broken down insulators for even the most up-to-date systems have breakdowns now and then from flaws in apparently good porcelain and stresses due to internal surges. The cables are arranged in an equilateral triangle by placing one cable at the top of the pole. The other two are on the crossarm. This formation is desirable to equalize the mutual induction of each wire on its mates and to facilitate transposition.

All the buildings and equipment of the system were designed to last and to accommodate large additional capacity. The available power at Upper Bonnington Falls is only partly developed even with the addition of another 8,000 h.p. unit, which is being installed at present. This last addition will be required to supply power for the electrification of the C.P.R. from Castlegar to Rossland. The sub-stations are all built along the same plans. Separate rooms are provided for each bank of transformers, the high tension switching equipment, and the switchboard and operating room. No provision is made for elaborate systems of relays to disconnect lines when the voltage drops or the current is interrupted. The simple inverse-time-limit overload relays afford sufficient protection on both the high tension and feeder switches.

The accompanying illustrations of power house No. 2 give some idea of the difficulty with which it was erected. 70,000 cubic yards of solid granite had to be excavated for the forebay, power-house site and tail race. The building is of reinforced concrete and is not at all ugly or out of keeping with the natural beauty of its surroundings. The interior is roomy and provision is made in the present building for four units of 8,000 h.p. capacity each. Two of these are installed and in operation and a third is now being installed as mentioned before.

In this article I have endeavored to omit the quoting of capacity data and similar information as I have always found that it makes wearisome reading. Instead of detailing the equipment of the powerhouses and substations, which is pretty much standard and is familiar to most students interested in power plant construction, I have outlined some of the conditions under which this system was constructed and is now operated. Every little system has troubles all its own and it is these peculiarities which make the descriptions of plants and systems interesting.

## THE MECHANICAL AND ELECTRICAL CLUB OF THE ENGINEERING SOCIETY

### 1. Name of Club.

The name of the Club shall be, "The Mechanical and Electrical Club of the Engineering Society." (The relation of this club to the Engineering Society is provided for in the revised constitution of the Engineering Society, adopted.

### 2. Membership.

(a) The membership of the Club shall be open to all students in Electrical and Mechanical Engineering in the Faculty of Applied Science and Engineering, University of Toronto. Such members do not require nomination or election.

(b) Others desiring to become members shall be elected by the Club. Such candidates shall be nominated at a regular meeting, the voting on this nomination to take place at the following regular meeting.

### 3. Divisions of Club.

The Club shall be divided into two sections, namely:

(a) A Senior Section consisting of members of the third and fourth years in Electrical and Mechanical Engineering.

(b) A Junior Section consisting of members of the first and second years in Electrical and Mechanical Engineering.

### 4. Officers.

(a) The officers shall consist of a chairman, a vice chairman, a third year councillor, a second year councillor, and a first year councillor.

(b) The chairman shall be a member of the fourth year and hold office on the Executive of the Engineering Society as provided in the Constitution of the Engineering Society.

(c) The vice chairmen shall also be a member of the fourth year.

### 5. Duties of Officers.

(a) It shall be the duty of the chairman to preside at all general meetings, call meetings for the election of an executive or for the transaction of any other business pertaining to the interests of the club. He shall enforce due observance of the constitution and by-laws, shall make no motion or amendment nor vote on any question or motion unless the club be equally divided when he shall give the deciding vote.

(b) The vice-chairman shall perform the duties of the chairman in the absence of that officer. He shall also preside at the meetings of the senior section, provide places for these meetings and arrange for topics of discussion. He shall also collect fees from the members of the fourth year.

(c) The third year councillor shall act as secretary to the club and also collect fees from the members of the third year. He shall keep a record of the proceedings of the club at the general and executive meetings. He shall also make mention in the minute book of the meetings of the two sections.

(d) The second year councillor shall act as treasurer, collect fees from the members of the second year and keep an account of all expenditures and receipts in an account and cash book. He shall also arrange the meetings of the Junior section and preside at such meetings.

(e) The first year councillor shall act as curator and shall also collect the fees from the members of the first year.

### 6. Election of Officers.

(a) The Chairman shall be elected at the annual elections of the Engineering Society.

(b) The vice-chairman, third year councillor and second year councillor shall be nominated at the last general meeting of the club, the elections to take place one week later.

(c) The first year councillor shall be nominated at the first general meeting of the fall term, elections to take place one week later.

### 7. Duties of Members.

(a) Members are requested to read papers before the club at the general meetings.

(b) It is the duty of all members to take part in any discussion.

(c) Papers presented shall become the property of the club.

### 8. Meetings.

(a) The general meetings shall be held once a month, alternately with the general meetings of the Engineering Society, such dates to be chosen by the executive of the Engineering Society. Meetings to commence at 4 p.m.

(b) The senior section shall hold their meetings on the first Thursday of the month at 8 p.m.

(c) The Junior section shall hold their meetings on the fourth Thursday of each month at 8 p.m.

(d) It is also recommended that these meetings be not addressed by an outside speaker, but that they take the form of open discussion in which everyone should take part. However, this is left to the discretion of the vice-chairman and second year councillor who are at liberty to form their own rules and regulations, provided that said rules and regulations meet with the favor of the executive of the Engineering Society.

**9. Fees.**

(a) The annual fee shall be twenty-five cents to members of the Junior and Senior sections.

(b) All fees shall be paid within the first academic month.

**10. Alterations to Constitution.**

Notice of motion regarding proposed alterations to the constitution shall be given at the previous meeting and a written notice of motion shall be handed to the secretary, voting to take place at the next general meeting.

### By-Laws Relating to General Meetings

**1. Rules of Order.**

(a) The order of business shall be as follows: Opening, reading of minutes, nomination of members, reading of communications, reports of committees, election of members, unfinished business, new business, programme and closing.

(b) The chairman, or in his absence, the vice chairman, shall conduct the meeting, or in the absence of such officers a chairman pro tem shall be chosen by the club.

(c) The chairman shall be privileged to debate on all subjects upon calling any member to the chair.

(d) The minutes shall not be amended except to correct error in fact.

(c) Any member who wishes to speak shall rise and respectfully address the presiding officer. He shall confine himself to the question under discussion and avoid personalities.

(f) If two or more members rise to speak at the same time the presiding officer shall decide who shall speak first.

(g) A motion must be moved, seconded and repeated aloud from the chair before it is open for debate.

(h) Motions must be written out and handed to the secretary, signed by the mover and seconder.

(i) When a member is called to order he shall resume his seat until the point of order is decided.

(j) An appeal may be made at all times from the decision of the chair. The presiding officer shall put the question, "Shall the decision of the chair stand as the opinion of the meeting." Two-thirds vote of meeting is necessary to sustain the appeal.

**2. Alterations to By-Laws.**

The same procedure shall be adopted as is provided for in changing the constitution.

## UNKNOWN ADDRESSES

The following is a list of graduates, regarding whose addresses we have not reliable information. Our readers will confer a favor if they will kindly advise us of the correct addresses of any of the men listed below:—

Abendana, E. M., '14; Alexander, J. H., '04; Allen, F. G., '07; Armour, R. H., '05; Bertram, G. M., '01; Binns, R. E., '13; Blair,

W. J., '02; Bowman, A. M., '86; Brackenreid, T. W., '11; Brown, D. B., '88; Brown, H., '11; Browne, E. W., '09; Bruce, W. J., '07 Campbell, A. W., '06; Campbell, R. J., '95; Campbell, A. M., '04; Campbell, A. J., '04; Cameron, M. G., '09; Carey, B., '99; Chambers, E. V., '14; Chantrell, E., '05; Charlebois, J. P. C., '08; Chisholm, D. C., '10; Christie, F., '06; Clark, J., '00; Coulter, G. P., '07; Darrich, J., '08; De Guerre, F. C., '11; Derham, W. P., '09; Dowling, F., '05; Elliott, J. C., '99; Evans, J. H., '11; Evans, S. D., '07; Foreman, W. E., '99; Forester, C., '93; George, R. E., '03; Gourlay, W. A., '03; Heebner, M. B., '11; Horton, J. A., '03; Hull, H. S., '95; Hunter, A. N., '08; Irwin, W. J., '10; Kay, E. W., '07; Kean, D. J., '09; Keefer, A. H. E., '09; Keys, W. R., '08; Lott, A. E., '87; Macdonald, F. R., '08; Macdonald, J. A., '10; Macdonald, J. B., '10; Macdougall, A. C., '01; McKay, A. G., '07; MacKay, J. T., '02; McKenzie, D. W., '05; McLellan, R. A., '11; McLeod, G., '09; McPherson, J., '06; McTaggart, A. L., '94; Malone, J. E., '08; Martin, F., '87; Matheson, W. C., '01; Maus, C. A., '03; Mennie, R. S., '02; Milligan, F. S., '10; Mitchell, L. C., '11; Montague, F. F., '06; Moore, F. A., '03; Munro, F. V., '03; Murray, J. D., '07; Niebel, E. H., '11; O'Brien, E. D., '05; O'Gorman, C. A., '09; Pae, A. W., '09; Parke, J., '04; Paton, T. K., '07; Paulin, F. W., '07; Pearson, C. L., '11; Pope, A. S. H., '99; Proctor, A. I., '09; Robertson, D. F., '03; Roaf, H. R., '00; Sanders, W. K., '06; Scott, W. A., '06; Shipley, A. E., '98; Smiley, R. W., '97; Smith, J. H., '03; Stamford, W. L., '08; Stevenson, W. H., '01; Taylor, W. V., '93; Thomas, V. C., '08; Wright, R. T., '94; Wilson, W. H., '10; Whelihan, J. A., '03; Villeneuve, T. L., '08.

## INFORMATION RE CORRESPONDENCE FOR PRISONERS OF WAR IN GERMANY

1. Letters (letters should be left open) postcards and postal parcels should be addressed as follows:—

1. Rank, initials, name.
2. Regiment, or other unit.
3. British (or Canadian, French, Belgian or Russian) prisoner of war.
4. Place of internment.
5. Germany.

Place of internment should be stated always, if possible, and parcels cannot be accepted unless place of internment is stated. All addresses must be in ink.

2. Communications should be limited to private and family news and to necessary business communications, and should not be sent too frequently.

No references to the naval, military or political situation or to naval or military movements and organizations are allowed. Letters or postcards containing such references will not be delivered.

3. Friends of prisoners of war are advised to send postcards

in preference to letters as postcards are less likely to be delayed. If letters are sent, they should not exceed in length two sides of a sheet of note paper and should contain nothing but the sheet of note paper. On no account should the writing be crossed.

4. Letters cannot for the present be accepted for registration.

5. Postage need not be paid either on letters or parcels addressed to prisoners of war.

6. No letters should be enclosed in parcels, and newspapers must not on any account be sent. So far as is known there is no restriction on the contents of parcels; tobacco may be sent and will be admitted duty free but food stuffs of a perishable character should not be sent. Parcels should not exceed 11 pounds in weight.

7. Remittances can be made by money order to prisoners of war. Instructions as to how to proceed can be obtained from postmasters of Accounting Post Offices. The transmission of coin, either in letters or parcels, is expressly prohibited. Postal notes and bank notes should not be sent.

8. It must be understood that no guarantee of the delivery of either parcels or letters can be given and that the Post Office accepts no responsibility. In any case, considerable delay may take place and failure to receive an acknowledgement should not necessarily be taken as an indication that letters and parcels sent have not been delivered.

9. So far as is known, prisoners of war in Germany are allowed to write letters or postcards from time to time; but they may not always have facilities for doing so and the fact that no communication is received from them need not give rise to anxiety.

## REUNION OF MONTREAL TOIKE OIKES

On the evening of May 7th a most enjoyable little reunion of about two dozen Montreal "School" men was held at the University Club, Montreal. Mr. Walter J. Francis occupied the chair and Dean Ellis the place of honor. At the conclusion of the dinner Dean Ellis proposed the toast to the "Toike Oikes at the Front" and reviewed some of the history of the School that was new to most present. Following the Dean, Mr. Ross expressed some felicitations while Mr. H. W. Fairlie, B.A.Sc., '10, who had just returned after a year's residence in Winnipeg, also spoke.

The annual elections were then held, and Mr. J. M. R. Fairbairn, '93, assistant chief engineer of the C. P. Ry., was elected president; Mr. W. D. Black, B.A.Sc., '09, vice-president, and Mr. W. H. Sutherland, B.A.Sc., '02, secretary-treasurer; while the old Advisory Committee of Messrs. J. M. Robertson, '93, D. C. Tennant, B.A.Sc., '09, L. R. Wilson, B.A.,Sc. '09, and C. W. B. Richardson, B.A.Sc., '07, was re-elected.

## FAREWELL DINNER TO MEMBERS OF CLASS 1913

On the evening of May 7th the members of year 1913, residing in Toronto, held a farewell dinner at the Walker House for their members who are leaving with the Second Canadian Expeditionary Force. Messrs. Chas. Avery and N. F. Parkinson of the 15th Battery C.F.A., were present, and the year greatly regretted the inability of the others to be with them. Mr. E. R. Gray, president of the class, was the toastmaster. After each member had had an opportunity to make a speech or tell a story, a business meeting was held at which it was decided to form a Toronto Branch of the class.

The following were elected as officers:—John S. Galbraith as president; and R. L. Hearn, of 249 Dovercourt Road, Toronto, as secretary. Each member of the year is asked to keep in as close touch as possible with these officers.

The men of this year who have already left on active service are:—First Contingent, A. J. Gray, C. A. Bell, C. B. Ferris, E. S. Foulds, L. C. M. Baldwin, A. G. Gray, F. S. Rutherford.

Second Contingent—J. McV. Strathy, F. F. Howlett, C. R. Avery, C. E. Kilmer, N. F. Parkinson, H. Webster, and B. H. Segre.

## C.O.T.C. CAMP

The Universities' Officers Training Corps camp which was held from May 3rd to May 15th, may be set down as a success in every way. Conceived as a preparation for self defence and carried out with the esprit de corps of college men, turned soldiers, all can agree with Colonel Lang when he expressed complete satisfaction with the results obtained.

The course of instruction was progressive in character. At first the men were put through the rudimentary exercises of squad drill. This was further developed until at the close of the camp the corps worked as a battalion. Practical examinations for those who had qualified on the written examinations, were also held.

For those who were not at camp an idea of the day's tribulations from the standpoint of a private may be of interest, and the fact that Professors Gillespie and L. B. Stewart were also privates in the strictest sense of the word is worthy of note.

Sometime in the middle of the night a bugle "goes" off and you find it is 5.45 a.m., and roll over only to be shortly awakened by the band playing some insane combination of futurist harmonies as it passes right through the lines. You have a few minutes' meditation and then the small fry get their innings. Sergeants and other non-coms. rush up and down the lines, "Double up men! Roll call. Always move at the double." Roll call and a short run are followed by the morning's ablutions and breakfast at 6.45 a.m. After cleaning the tents and taking physical exercise, everybody drills until noon. From 2 p.m. to 4.30 drill is continued and then everybody is off for the day.

The camp was inspected by Gen. Lessard on May 13th and again the same afternoon H.R.H. the Duke of Connaught critically inspected the corps. On Friday a field day was held followed by a march past before Gen. Hughes. This completed the work of the camp and on May 15th it was a bronzed lot of men that marched gaily up University Ave. to be dismissed until individually called on to serve their country by the call of duty.

## ON ACTIVE SERVICE

The following "School" men have enlisted with the Second Canadian Contingent, in addition to those previously mentioned in Applied Science:—

J. L. R. Parsons, '01; E. R. Birchard, '09, with Eaton Battery.

E. G. MacKay, '10, with 91st of Hamilton.

A. L. Steele, '10, with Canadian Engineers at Ottawa.

E. F. Chesnut, '11, with No. 1 Co. 19th Battalion.

L. E. Jones, '11; A. M. Mackenzie, '14; G. H. Hally, '14, with 26th Battery at Kingston.

A. G. Scott, '15, with 42nd Regiment at Petawawa.

J. A. Tom, '15; I. M. Macdonell, '15; H. K. Wyman, '15; C. N. Geale, '15, and G. A. Gooderham, '15, with Aviation Corps at the Island.

C. C. Anderson, '16, R. Tyrwhitt, '16, with Stationary Hospital, C.E.F.

A. H. Macfarlane, '16; A. M. Thomas, 16, with No. 2 Co., 35th Battalion.

C. H. Wheelock, '16, with Machine Gun Det., 35th Battalion.

P. A. Durbrow, '17, with 8th Bde., C.F.A.

W. A. Bishop, '17; V. E. Ives, '17; F. R. Allan, '18; Machine Gun Det., 35th Battalion.

L. J. Deacon, '18, with 7th Bde., 26th Art.

H. W. Orr, '18, with 26th Battery, 7th Bde.

C. E. Kilmer, '13.

To date we have record of 69 "School" men with the First Contingent and 127 with the Second Contingent, exclusive of those enlisting with the Second University Overseas Company.

## SCHOOL MEN ON THE CASUALTY LIST

Jeff Taylor, '08, has just been reported killed.

Lieut. E. A. Greene, B.A.Sc., '11, of 9th Battery, is reported missing.

Capt. D. H. C. Mason, B.A.Sc., '07, of 1st Brigade, 3rd Battalion, is reported missing.

Sergeant C. A. Bell, '13, of 3rd Brigade, 2nd Fd. Co'y is reported missing.

Pte. A. G. Code, B.A.Sc., '10, of Canadian Army Service Corps, reported seriously wounded.

Capt. R. Y. Cory, B.A.Sc., '08, Canadian Army Service Corps, 15th Battalion, reported prisoner.

Lieut. H. F. H. Hertzberg, '07, of 2nd Field Co., Canadian Engineers, has been wounded.

Lieut. G. E. D. Greene, B.A.Sc., '09, of 3rd Battalion, is reported prisoner.

Lieut. Herbert N. Klotz, '09, killed while fighting around Ypres.

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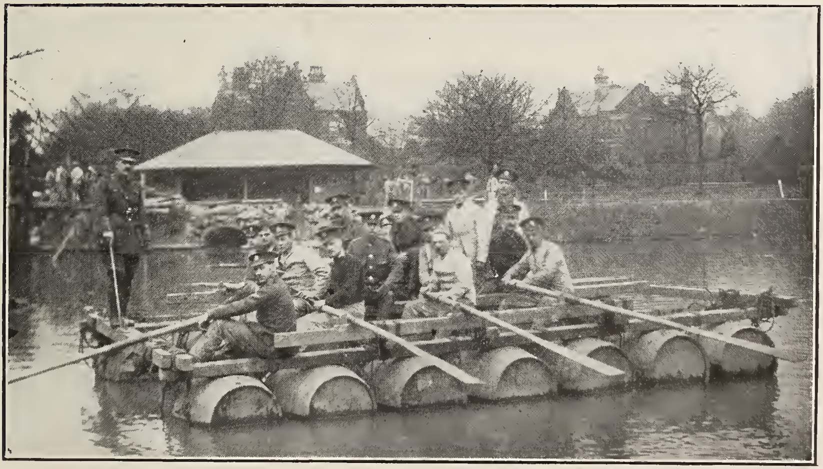
One of the School men to receive recognition from the Imperial Government is M. B. Watson, 1910, who went over to England with the First Canadian Overseas Expeditionary Force. Shortly after his arrival at Salisbury he received a commission as 2nd lieutenant in the Royal Engineers, and is at present doing instruction work at Buxton, England.

While attending the School, Mr. Watson was connected with the 2nd Field Company, Canadian Engineers, receiving his corporal's stripes. On the outbreak of war he enlisted with his old company and trained with them at Valcartier, where he was, for part of the time, in charge of the local telephone system.



The accompanying photograph shows Lieut. Watson standing on the end of a barrel raft which was built under his instruction in 20½ minutes. Since leaving Toronto he has gained 20 pounds, and as may be seen from the photograph, has cultivated a very creditable eyebrow on his upper lip.

# Editorial

**UNIVERSITIES' OVERSEAS COMPANY**

Following the suggestion of Capts. MacDonald and Molson, of McGill University to Hamilton Gault, that reinforcements for the Princess Patricia's Canadian Light Infantry be recruited from the C.O.T.C., the first University Overseas Company was formed at Christmas at McGill. It has been in training ever since with Capt. MacDonald in charge and Capt. Molson second in command. The subalterns being Capt. G. M. Smith, of Victoria College and Lt. D. G. Hagarty, '16. The first company is now in camp at Niagara and recruits are being called for the second company. It is hoped that the 110 men which Toronto is expected to contribute, may offer their services very shortly.

The company is not attached to any battalion and the work will not be wholly regular infantry drill but mutual instruction will be the strong point. As officers are very scarce in England it is the object of this company to qualify its men as officers so that they can obtain commissions when arriving in England. To date about 50 School men have enlisted and should any graduates be seriously considering going to the front no better opportunity could be offered them.

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**IRISH CHANNEL RAILWAY**

In the November, 1913, issue of Applied Science appeared an article on the unifying of the British Empire by "A Railway Across the Irish Channel" proposed by H. G. Tyrrell, C.E., '86. This article at the time it was published was much discussed in British papers and magazines, and also in the British Parliament. The following extract from an article on this subject in Popular Science for October, 1913, sets out a few of the measures advocated by Mr. Tyrrell as precautions in case of war.

"The Irish Channel railway is of international interest and importance because it would form one link in the proposed Imperial Route connecting all parts of the British Empire. Over this route it is intended that travel should be conducted with the greatest possible speed, and in the event of war, Great Britain would have independent communication with all parts of the Empire and could receive supplies from Australia and New Zealand in about twenty-one days. Its course would lie across the Atlantic and Pacific oceans by way of Canada, instead of through the Suez Canal and the Mediterranean Sea, and past the ports of foreign countries. Food Supplies from Canada and the west would then arrive in Great Britain at ports on the west coast of Ireland, which in times of war, would be much safer than others further to the south or on the English Channel adjoining France."

The wisdom of this plan is now all too evident, though too late. However, when the war is over the northern Irish ports will doubtless be developed.

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### SIGNS OF THE TIMES

Great is the credit due Canada for weathering the difficulties of economic adjustment as she is. Money is accumulating rapidly and the change from the British to United States money market was effected without trouble. The chartered banks, which are the safety valve of Canada, are in an excellent position and extend credit when it is deserved. The agricultural prospects are good and trade is improving. Few mortgage payments, of either principal or interest, are in default. Manufacturers are cutting new trade channels, encouraging home demand, and increasing their exports. In short, everything indicates a period of prosperity for Canada.

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### MADE IN CANADA

We must not forget that it was upon German science that the trade of Germany was developed to such a marked degree. The very base of all their industries was science and particularly the science of chemistry. The standardizing of all products, the development of industries, the invention of new products, the utilization of by-products, etc., all depend on chemical research. It is, therefore, quite evident that for Canada to become a "Made in Canada" country the chemical engineer has a great future ahead of him and is bound to become more and more the power of commerce.

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### AVIATION

Toronto is one of the continent's busiest centres of aviation. But two weeks ago there was only one aeroplane around Toronto and now there are seven. In a few weeks Toronto has become the greatest flying centre on the continent, and it will not be long before the machines, motors and practically all equipment will be built here. Should the war establish the aeroplane industry on a firm footing in Toronto, the credit will be due to a few enterprising men, who have worked without any government help, such as other countries give. One of these men is J. A. D. McCurdy, '07, managing director of the Curtiss Aeroplane & Motors, Ltd., who is looking after the Curtiss-McCurdy flying school at Hanlan's Point. They have four machines that are used in the course of instruction. For the early training the flying boat and slow land machine are used, while for finishing the course in land flying a powerful tractor, making 85 miles per hour, is used. The final stages are performed in a 160 horsepower flying sea-plane. The school will accommodate a class of thirty at a time.

## PERSONALS

**School Men on Hudson Bay Railway**—Le Pas Division—J. P. Gordon, '04, assistant chief engineer. Division No. 2, Goose Lake, Mile 137—A. L. McNaughton, '03, resident engineer. Division 3, Landing River, Mile 280—S. Hett, '06, resident engineer. Division 4, Landing River, Mile 280—J. W. Scott, '11, resident engineer.

**John S. Galbraith,** B.A.Sc., '13, has received a commission with the 10th Royal Grenadiers and is going into camp with them at the end of May.

**E. E. Hugli,** B.A.Sc., '14, is draughting for the Mond Nickel Co., Coniston, Ont.

**C. N. Geale,** B.A.Sc., '15, and **G. A. Gooderham,** B.A.Sc., '15, are in training with the Aviator Corps at the Island.

**G. A. Colquhoun,** '06, is estimating and designing engineer with the Hamilton Bridge Works. His address is 29 Sophia St., Hamilton.

**T. G. Gravely,** B.A.Sc., '11, is on shell inspection work with John Bertram & Sons, Ltd., Dundas, Ont. His address is Box 158, Dundas.

**W. C. Blackwood,** B.A.Sc., '06, has been appointed director of physics for the Central Technical Schools, Toronto.

**W. A. Cowan,** '04, formerly of the Intercolonial Railway, has been appointed to the staff of Mr. F. P. Brady, divisional engineer for the Transcontinental Railway at Cochrane, Ont.

**A. P. Linton,** B.A.Sc., '06, assistant chief engineer, Board of Highway Commissioners for Saskatchewan, last week addressed the Regina Engineering Society on the Construction of the Traffic Bridge at Saskatoon.

**Mr. K. H. Smith,** '11, has been appointed resident engineer for the Dominion water Power Branch at Halifax, N.S., to have charge of field investigations covering the water powers of the Province of Nova Scotia. The investigations are being carried on under a co-operative arrangement between the Nova Scotia Water Powers Commission and the Dominion Water Power Branch.

Readers of APPLIED SCIENCE will be glad to hear of the very interesting and unique water power exhibit which has been arranged by the engineers of the Dominion Water Power Branch in the Canadian Pavilion at the Panama-Pacific International Exposition. As this exhibit has been conceived and carried out entirely by "School" men, APPLIED SCIENCE is arranging for a special descriptive article which will appear in a forthcoming number.

The following "School" men have recently been appointed to the staff of the Dominion Water Power Branch, Department of the Interior:—

**Harold Leach,** '14; **George Woods,** '16; **J. T. Rose,** '15.

These men will all be attached to the staff of the Manitoba Hydrographic Survey, of which Mr. M. C. Hendry, '05, is chief engineer.

The Canadian Government has recently arranged to have a reconnaissance survey made of the water powers of the Yukon territory. This work will be carried on under the personal direction of R. G. Swan, B.A.Sc., '09, chief engineer of the British Columbia Hydrographic Survey.

## NEW AMMUNITION COMPANY

The Montreal Ammunition Co., of which Mr. H. H. Vaughan is president and Mr. G. H. Duggan, '83, vice-president, is a newly organized concern that will manufacture brass cases for shrapnel and high explosive shells. Heretofore these cases have not been manufactured in Canada, but orders were filled in Detroit and other cities of the United States. The new company will use part of the plant of the Dominion Bridge Co. for its work. Mr. Duggan is general manager of the latter company, while Mr. Vaughan resigned his position as chief mechanical engineer of the C.P.R. to devote his time to the new concern.

## OBITUARY

The death of Mr. T. Harry Mace, '05, occurred last week. For some time he has been associated with the patent office of the Dominion Government at Ottawa, and prior to this had a consulting practice here in Toronto. The deceased was also a member of the 3rd Field Company of Canadian Engineers.

We wish to convey our sympathy to Mr. A. V. Trimble, '04, in the loss of his beloved wife, who died suddenly on Sunday, May 2, at 94 Glendale Avenue.

### Lieut. Herbert N. Klotz, '09

Following closely upon a letter written from northern France to the effect that he never felt better in his life and was enjoying himself, came a message that shattered all hopes of a safe return. Lieut. Klotz was always an ardent military man, and while attending Harbord Collegiate, took an active interest in the cadet movement. After graduating from the "School" he was engaged as a chemist with the Gutta Percha & Rubber Company, and was with them until he received a commission with the Mississauga Horse, and enlisted with the First Contingent. He is survived by his father, Mr. E. W. Klotz, of 40 Sussex Avenue.

## APPLIED SCIENCE EXAMINATION RESULTS, 1915

### PROFESSIONAL DEGREES

**Degree of Civil Engineer—**

G. A. Bennett, B.A.Sc., '10 (C.E.); J. B. Challies, '04 (C.E.); E. A. Davison, B.A.Sc., '05 (C.E.); Angus Smith, '94 (C.E.); D. S. Stayner, B.A.Sc., '10 (C.E.).

**Degree of Mining Engineer—**

A. D. Campbell, B.A.Sc., '11 (M.E.); B. Neilly, B.A.Sc., '08 (M.E.).

**Degree of Mechanical Engineer—**

A. M. Campbell, B.A.Sc., '05 (M.E.).

**Degree of Electrical Engineer—**

C. E. Palmer, B.A.Sc., '11 (E.E.).

**Degree of Master of Applied Science** (M.A.Sc.)—

C. R. Avery, B.A.Sc., '13; N. F. Parkinson, B.A.Sc., '13; C. S. Robertson, B.A.Sc., '13; O. Rolfson, B.A.Sc., '07; G. E. Treloar, B.A.S.c, '14.

### SCHOLARSHIPS

The Boiler Inspection and Insurance Co.'s scholarship for general proficiency in mechanical engineering for the third year is awarded to L. L. Youell.

### STANDING GRANTED ON ACCOUNT OF ACTIVE SERVICE

The following candidates have been granted standing in their respective years on account of having enlisted for active service:

**First Year**—T. B. Jack.

**Second Year**—W. H. Aggett, W. B. Andrew, W. D. Armstrong, W. H. Bauer, W. A. Bishop, E. S. Byers, E. R. Dafoe, P. A. Durbrow, E. B. Dustan, C. Hewson, J. H. Legate, F. A. McKinley, A. F. Norris, C. H. Smith, J. Ward, J. F. Young.

**Third Year**—C. C. Anderson, T. E. Armstrong, S. K. Cheney, T. A. Daniels, C. W. Edmonds, W. F. Hadley, F. J. Matthews, A. R. Mendizabel, F. S. Merry, H. B. Norwich, V. R. Pfrimme, W. W. Ritchie, C. Smythe, H. Stewart, A. A. Swinnerton, A. M. Thomas, A. B. Whaley, C. H. Wheelock, J. S. Wilson,

**Fourth Year**—R. M. Arthur, H. J. Burden, W. G. French, R. D. Galbraith, M. S. Haas, I. M. Macdonell, K. D. McDonald, E. V. McKague, W. D. Powell, W. E. Raley, G. W. Rutter, A. G. Scott, W. G. Shier, R. B. Sinclair, J. A. Tom, J. N. Williams, H. K. Wyman, B. M. Morris.

The degree of B.A.Sc. was conferred upon the following at a special convocation held last February: F. D. Austin, N. H. Daniel, W. E. Lockhart, W. B. Redman, L. B. Tillson.

Candidates whose names are followed by brackets must pass supplemental examinations in the subjects indicated:—

## First Year

**Civil Engineering**—

Honors—J. C. Angus, J. C. Aykroyd, J. M. Breen, H. R. Burton, W. L. Clairmont, C. P. Coatsworth, O. G. Darling, H. J. Elliott, H. W. J. Fairclough, J. A. Garvi, R. B. Gordon, H. Harrison, S. H. Johnston, F. T. Julian, J. A. Langford, N. G. McDonald, P. L. McGavin, L. McGee, R. Mitchell, J. R. Mitchener, T. H. Norval, G. M. Pearce, G. V. Rayner, J. Roosky, W. L. Sagar, M. Samuels, C. R. Scott, D. G. Scott, G. E. Steele, H. G. Thompson,

Pass—E. Birdsall, W. G. Brown, F. W. Campbell, F. D. Ellis (algebra), N. H. Kearns, G. K. MacKendrick, K. J. McEachern (trigonometry, anal. geom.), C. R. Maddock (algebra), W. J. Parker, S. H. Pepler (elem. chemistry), D. A. Robertson, F. W. Simpson, C. H. Stalker, A. K. Sweetman (alg., trig.), F. H. Taylor, C. C. Wimperly.

**Mining Engineering**—

Pass—N. Bowman, C. A. Richardson.

**Mechanical Engineering**—

Honors—F. J. Booz, M. G. Lymburner, P. F. McIntyre, S. A. McLennan, J. A. Simmers, M. L. V. Weir.

Pass—R. A. Connor (trig.), M. E. Dickenson (anal. geom., German), H. T. Gorrie (alg., trig.), H. J. McCreary (alg.), J. H. Peters (trig., anal. geom.), W. D. Robertson (elec. lab., trig.), W. J. Scott, (anal. geom.), P. E. Williams (alg.).

**Architecture**—

Honors—G. R. Gouinlock, T. J. Young.
Pass—W. A. Mollard.

**Analytical and Applied Chemistry**—

Honors—J. E. Fasken.
Pass—J. E. T. Musgrave (trig., anal. geom.), M. D. Schell (alg.).

**Chemical Engineering**—

Honors—J. A. Affleck, R. D. Affleck, J. H. Forman, G. E. Goble.
Pass—K. H. Chamberlain (elec. lab.).

**Electrical Engineering**—

Honors—C. K. Duff, K. S. Gemmel, J. P. McClelland, E. W. McLeod, W. H. Orr, G. R. Shephard, J. M. Souter, G. F. Tracy, H. S. Weldn, C. M. Willey.

Pass—W. D. Brown, G. F. Bryant (anal. geom.), J. W. Gardner (trig., anal. geom.), F. E. Johnston, K. D. Kayler (trig.), G. L. Macpherson, C. J. McNamara, J. H. McVean, T. W. Penhale (trig.), W. M. Smith (trig.), G. B. Wigle, F. A. Wood, W. G. Woonton (alg.).

### Second Year

**Civil Engineering—**

Honors—A. E. Berry, R. S. C. Bothwell, G. A. H. Burn, F. C. Christie, R. A. Crysler, W. P. Dale, R. R. Hawkey, U. C. Holland, C. A. Hughes, W. H. Hunter, R. W. Hurlburt, R. E. Jones, J. R. McLean, R. C. Manning, H. A. Parr, C. L. Pool, W. D. Proctor, R. D. Ratz, G. E. Stephenson, C. E. Tilston, V. Topping, G. E. Waite, R. S. Warwick, L. E. Willmott, G. Wood, N. C. Wood.

Pass—O. V. Ball, H. F. Coon, E. H. Corman, F. C. Darch (mineral lab., hydrostat.), H. L. Dowling, J. A. Fraser, J. R. Gilley (Fr.), W. K. Greatrex. L. H. Ingersoll (optics), E. W. Johnston (calc.), W. J. Le Clair, G. A. McEwen, F. McGinn, F. L. Mitchell, E. L. Moorehouse, (Fr.), C. E. Newman (sph. trig., survey), H. R. Nicholson, J. E. O'Brien, W. J. Peace, G. P. Pearson, T. J. L. Ryan (survey), L. R. Shoebottom, G. H. Sohn (calc.), G. W. G. Stevenson (calc.), R. E. Taylor, A. P. Thomson, E. Thompson, G. A. Webb (Fr.), G. A. Whately.

**Mining Engineering—**

Honors—E. R. Gilley, G. Hanmer, H. L. McClelland, J. E. Sharman.

Pass—E. R. Howes (calc., inorg. chem.), H. D. Wallace (calc.).

**Mechanical Engineering—**

Honors—E. Bell, M. G. Henderson, J. D. Relyea, A. M. Snider, C. E. W. Tindale.

Pass—A. B. Harris, S. G. McCandish, (calc.), E. McIlhargey (theo. of mechan., bank. and fin.), A. W. Swan (hydrostat.), D. D. Vaughan (calc.).

**Architecture—**

Honors—E. W. Haldenby, A. S. Mathers, H. R. Watson.

Pass—J. Banigan (calc.), F. R. Gibson (ord. of arch.), C. C. Thompson.

**Analytical and Applied Chemistry—**

Honors—J. V. Dickson.

Pass—O. G. Lawson (phys. chem., bank. and fin.), G. G. MacDonald (elec.), E. J. Tyrrell.

**Chemical Engineering—**

Pass—A. G. Knight (calc., metall.).

**Electrical Engineering—**

Honors—R. A. Barbour, G. E. Booth, F. M. Bryans, C. E. Burton, J. C. Colleran, C. E. Harrop, R. D. Huestis, G. F. Hutcheson, W. J. Nichol, E. W. Smithson, O. W. Titus, A. A. Tufford, J. S. M. Wallace.

Pass—J. Ballinger (calc.), S. B. Bingham, (calc.), H. S. Brown (calc.), S. W. Bumstead, N. Burwash (calc.), R. T. Eyre, D. E. Ferrier, J. I. Gram (calc.), A. F. Hanly (calc., theo. of mech.), M. Johnston (calc., optics), L. Levesque, W. A. R. Offerhaus, H. Reed, H. A. Tuttle.

### Third Year

**Civil Engineering—**

Honors—E. B. Allan, H. A. Babcock, L. F. Barnes, W. L. Dobbin, J. H. Eastwood, M. Gurofsky, O. Margison, W. B. Mitchell, C. H. Ney, J. E. Pringle, S. R. Ross, W. B. Scott, R. L. Seaborne, R. L. Sievewright,

Pass—B. W. Bemrose (survey), E. Crosby, R. S. Dale, L. F. Gaboury (astron. and geod.), D. B. Gardner (astron. and geod.), D. G. Hagarty, G. C. Hagedorn (astron. and geod., theo. of struct.), R. M. Hare (astron. and geod., hydraul.), L. W. Harren, (theo. of struc.), C. E. Hastings, K. D. Jackson, J. R. Kirby, R. W. Kirby, L. A. Lee (astron. and geod.), J. R. McColl, E. A. O'Collaghan, N. L. Powell (theo. of struc., calc.), H. C. Rose (astron. and geod., hydraul.), G. B. Snow, R. M. Speirs (astron. and geod., theo. of struct.), F. S. Storms, J. A. Sureda, J. E. Tremayne (least sq., theo. of struc.), R. C. Ward.

**Mining Engineering—**

Honors—B. A. McCrodan.

Pass—F. W. Norton.

**Mechanical Engineering—**

Honors—J. R. Chapman, R. W. Kirn, J. C. Newcombe, J. P. Russell, H. A. Washington, L. L. Youell.

Pass—H. E. Breuls (alt. curr.), J. N. Cunningham, J. L. Delisle (thermo., calc.), A. Fleming, R. A. Macdonald (thermo., mech. of machin.), J. M. Watson.

**Architecture—**

Honors—R. T. C. Hoidge.

Pass—L. Husband, W. S. Kidd, G. H. Schwartz, J. L. Skinner (theo. of struct.), A. F. R. W. Swinnerton (theo. of struct., photo.).

**Analytical and Applied Chemistry—**

Honors—W. G. Birrell, N. B. Brown, J. E. Clark.

Pass—F. W. Ward.

**Chemical Engineering—**

Honors—D. Boyd, C. E. Oliver.

Pass—S. J. Krug.

**Electrical Engineering—**

Honors—K. Cumming, L. L. Cunningham, L. G. Dandeno, E. G. Gurnett, G. E. Nott, A. R. Wells, H. S. Weppler.

Pass—F. C. W. Ball, F. W. Booth (thermo., mech. of machin.), R. L. Flegg, (thermo.), R. A. Fraser (hyd. lab.), S. J. Hubbert (elec. chem.), J. Kelleher (thermo., mech. of machin.), G. F. King (thermo., alt. curr.), T. R. Manning, J. Richmond, S. W. Ross, W. A. Smalser, A. E. Widdicombe.

### Fourth Year

**Civil Engineering—**

Honors—G. A. Arksey, P. Bennett, R. H. H. Blackwell, E. D. G. Brouse, L. R. Brown, E. M. Buchanan, J. D. Cook, A. B. Crealock, E. V. Deverall, W. L. Dickson, G. A. Downey, W. R. Da Costa, W. R. Fraser, W. J. Fulton, E. R. Grange, C. E. Hogarth, C. W. H. Jackson, G. W. F. Johnston, R. E. Laidlaw, G. J. Lamb, H. O. Leach, W. E. Longworthy, C. T. Lount, R. G. Lye, C. A. Macdonald, H. E. Macpherson, W. R. McCaffery, C. R. McCort, J. P. McDonald, D. F. McGugan, W. H. Meitz, G. Mitchell, M. A. Neilson, H. S. Nicklin, R. A. Paul, H. M. Peck, C. F. Porter, J. E. Porter, G. Rankin, A. A. Richardson, H. M. Rowe, E. H. Scott, R. G. Scott, J. H. Shaw, C. N. Simpson, H. B. Thompson, L. P. Vezina, P. E. Weir, C. W. West, J. C. Wilson, H. A. Wood.

Pass—L. S. Adlard, A. C. Anderson, F. N.D. Carmichael, J. C. Christner (3rd year theo. of struct.), R. M. Cockburn, A. C. Evans, H. S. Falconer, J. W. H. Ford, C. N. Geale, (3rd year theo. of struct.), G. A. Gooderham, E. D. Gray (conditioned), G. S. Gray (thermo., 3rd yr. hydraul.), C. Hayward, E. H. Jupp, J. T. Mogan (hydraul. turb.), E. B. O'Connor, W. M. Omand, L. P. Pearce, S. M. Peterkin, C. C. Rance, J. T. Rose, J. S. Sheehy.

**Mining Engineering—**

Honors—W. T. Hall, J. E. Hanlon, L. T. Higgins, J. B. Stitt, J. E. C. Stroud.

Pass—E. R. Emmerson, D. S. Halford, R. D. Jones (metall., 3rd yr. metal.), F. L. Mills, J. M. Muir, J. Ross (thesis, metall.),

**Mechanical Engineering—**

Honors—C. G. Davey, R. H. Lloyd, W. R. McGie, A. N. Payne, F. G. Reid, A. S. Robertson, A. H. Smyth.

Pass—J. Gray, J. D. Stone, G. D. Tillson (hydraul. turb., thermo.).

**Architecture—**

Honors—R. W. Catto, T. S. Graham, A. Morris.

Pass—J. J. Davidson, G. R. Edwards (calc.), H. P. Frid (modelling).

**Analytical and Applied Chemistry—**

Honors—H. Kohl, W. D. Morris, W. Uffelmann.

**Chemical Engineering—**

Honors—J. E. Breithaupt.

Pass—L. G. Glass, F. J. Relyea.

**Electrical Engineering—**

Honors—W. V. Ball, T. R. Banbury, V. A. Beacock, H. M. Black, G. P. Davidson, W. A. Dean, J. Dibblee, R. V. Elliot, W. H. R. Gould, G. A. Ironside, G. W. Lawrence, E. M. Monteith, A. C. Ross, E. W. Savage, W. A. Steel, G. C. Storey, A. N. Suhler, A. L. Ward.

Pass—A. R. Birrell, W. H. Borus, H. C. Budd, F. H. Chandler (thermo.), W. W. Code (thermo.), D. T. Flannery, G. D. Gray, G. E. Griffiths, T. P. Ireland, K. A. Jefferson, C. M. Jones, C. R. Keys, J. S. McIntyre, E. T. Martin, (3rd year elec. chem.), W. P. P. Purdy, W. E. Russell (elec.), N. F. Seymour, A. N. Taylor.

### Supplemental Examinations Passed

The following candidates have passed supplemental examinations in subjects within the brackets:—K. W. Jamieson (elec. chem.), R. A. Cross (trig., elec. lab.), W. B. Honeywell (elec. and mag.), G. S. Stratford (optics), B. MacKendrick (3rd yr. theo. of struct.), D. Sutherland (elec.), E. M. Abendana (4th yr. theo. of struct.), S. B. McGill (thesis), A. H. Parker (thesis).

**Supplemental Examinations to be taken**—
K. W. Jamieson (trig.), G. S. Stratford (calc.).

## DIRECTORY OF THE ALUMNI

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Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO
ENGINEERING SOCIETY

Old Series Vol. 27 TORONTO, JUNE-JULY, 1915 New Series Vol. X. No. 2-3

# THE MODERN TERROR OF THE DEEP

## A Brief History of the Development of the Submarine With an Analysis of the Present Types, Their Powers and Limitations

Staff Article

To the casual reader of the daily war news the word "submarine" conveys the idea of a type of craft of unknown dimensions that is capable of dealing, single handed, with battleships of the largest and most formidable type. Day by day we hear of the sinking of trawlers, merchantmen, passenger liners, and occasionally ships of war by these unseen terrors of the deep. No one doubts the effectiveness of this recently developed arm of the modern navy, but it has come into prominence so rapidly that we are inclined to think that the birth of the idea of such craft dates back but a few years.

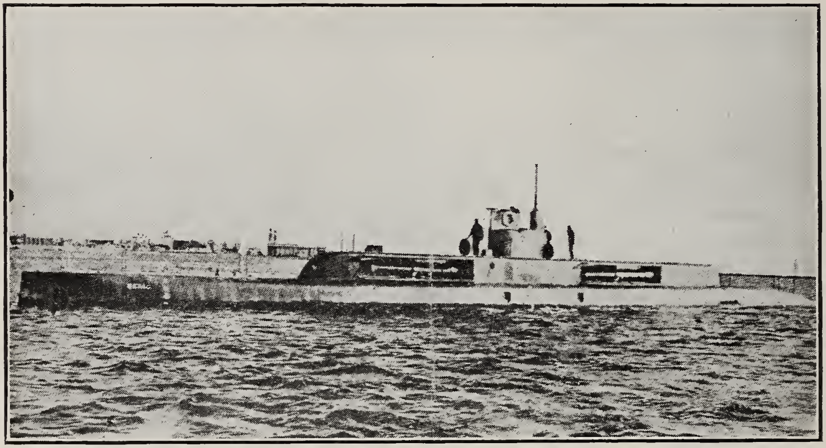
The first form of the submarine was the diving bell used in the time of Alexander the Great. In 1850, William Bourne, an Englishman, is said to have developed the idea, constructing a more mobile form. Of either of these little is known, however. The reign of James I. saw the further evolution and it is stated that that monarch was a passenger in a boat built by Cornelius Van Drebbel.

As an actual weapon of war the submarine was used in an attack on the British Battleship Ramilles off New London. This boat was of ovoidal shape, flattened at the sides and had a conning tower large enough to admit a man's head and shoulders. The crew consisted of one man, the pedal extremities of the observer being the motive power. By means of foot cranks the boat was propelled at a speed of from two to three knots. The striking power consisted of a wooden magazine fastened to the after, upper part of the hull. This carried about 150 pounds of gunpowder and was detachable. A screw, capable of being turned from inside the boat and arranged so that the outer portion could be let go forced the iron-clad magazine through the hull of the hostile craft, where it was caused to explode. The first attempt on record, that of the attack on the Ramilles, was a failure owing to the copper sheath on the hull preventing the operator of the submarine from driving his weapon home.

Between 1796 and 1810 Robert Fulton built several boats, but died before his last effort was given a trial trip. It was 80½ feet long and was propelled by a steam engine. Shortly after this the first boat to use compressed air as motive power was built in France by Charles Brun.

In 1896 two forms of propulsion were used for the first time by M. Lanbeuf. This gave rise to the distinction between the "submarine" and the "submersible."

While all the previous attempts were more failures than successes, they laid the foundation for what may be called the modern submarine, which was first built by J. P. Holland, of Paterson, N.J., in 1899. The Holland Type of submarine is one of those used at the present time, although of course greatly developed. In 1901-1902 seven of these were launched by the United States. Their general dimensions were—length, 63 feet, 4 inches; beam, 11 feet, 9 inches; displacement, 120 tons; Gasoline engines were used when travelling on the surface and electric motors when submerged. They attained a speed of 6½ knots under the surface and 9 knots with decks awash. At this speed the radius of action was 400 miles.



Lake Type of Submersible

As now used by the great powers there are two distinct types of under water boats. The "Submersible" is built primarily for work on the surface but is capable of being submerged. The "Submarine," on the other hand, comes to the surface only to make observations, attack by means of disappearing guns or to receive a fresh supply of air. Hence the forms of the two types differ. The submersible is built with a hull conforming to the general lines of the ordinary surface vessel, while the submarine is cigar-shaped.

The ship-shaped form of the submersible is, however, attained without abandoning the advantage of the circular section which is maintained throughout an inner spindle-shaped "strength-hull," being the form best adapted to resist the pressures of the water. Between the inner and the outer shell are water-ballast tanks and oil tanks, whence the strength-hull may be of small diameter well suited to resist great pressures without going to excessive scantlings.

The other hull, not being exposed to great pressures, may be lightly built, but will yet in some measure protect the inner hull against damage by collision. The ballast and oil tanks may, with a relatively small addition in hull weight, be made very large, whence a great reserve buoyancy and great radius of action can be secured. In a submarine the tanks are chiefly inside the strength-hull and cannot, therefore, be very large without unduly increasing the diameter of the hull and hence its tendency to collapse.

Speaking broadly the submersible has better sea-going qualities, and higher speed on the surface than the submarine, but the form is not so favorable for driving under water.

The reserve buoyancy in the early submarines was only about 5 per cent. of the light displacement but has been gradually increased to about 18 or 20 per cent. In submersibles, on the other hand, the reserve buoyancy has been reduced from about 72 per cent. in the first boat of this type, the French Narval, to about 35 per cent. or less in recent boats.

The submersible, as, for instance, the Germania type, has a relatively high centre of gravity and hence small stiffness in submerged condition on account of the high position of the tank structures, while in the surface condition the stiffness is in some cases excessively great due to the large area of the waterline. The submarine, exemplified by the Holland boats, has a low centre of gravity on account of the low-lying water tanks and therefore great stiffness in the submerged condition, but small or moderate stiffness on the surface. The Laurenti type, where the ballast tanks are partly below the strength-hull, partly above or, at least, very high, are intermediate between the Germania and the Holland type in this respect.

In order to obtain sufficient stability in the submerged condition submersibles must generally carry a considerable amount of keel-ballast. This of course is a drawback, but also most submarines carry some ballast. Part of the ballast is generally detachable, often referred to as a "safety keel," to be let go in case of emergency. In passing from the light to the submerged condition and vice versa a point will exist where the stability is a minimum, being reduced by the presence of free water in the tanks. The designer must, therefore, carefully determine the conditions of stability in all intermediate positions in order to satisfy himself that a proper metacentric height is always maintained. If the stability vanishes at any point the boat may heel over to a considerable angle before equilibrium is restored, or may even capsize.

The hull of a submerged vessel is exposed to an external water pressure which is directly proportional to the depth of immersion. Already at a depth of 200 feet the pressure is about 100 pounds per square inch, and since the depth of water in the ocean is generally more than ten thousand feet, boats cannot be constructed to withstand the pressures at all depths which they may encounter. It is therefore necessary to assign a limit to the head which a boat is required to resist. Generally there will be no object in going deeper than required to clear the bottom of vessels on the surface, that is to a depth of about 75 feet, but accidentally boats may descend involuntarily to greater depths. Usually the head to which boats are tested is about 150 feet, in the United States Navy it is 200 feet. A certain margin of safety is, of course, applied in the construction, but if a boat goes much beyond its test depth it is liable to collapse. In most boats the strength-hull is made of circular section as stated above.

## Navigation

Steering in a horizontal direction takes place as in ordinary vessels, but steering in the vertical plane has caused many difficulties to early inventors. Mr. Holland introduced diving and emerging by inclining the boat at considerable angles, while most other inventors preferred to keep the boat as nearly as possible on an even keel and to effect great changes in depth either by pumping water in or out of the boat, or by means of horizontal propellers, or by so-called "hydroplanes." The last method appears to be that which is mostly used in submersibles. Hydroplanes are similar to rudders, sometimes fitted amidships abreast of the centre of gravity of the boat, sometimes placed forward and turned the same way as the aft rudders. In all cases the object is to produce an upwards or downwards force driving the boat up or down parallel with iteslf. This method is generally considered safer than the "porpoising" used in the Holland boats. Once the desired depth is attained, it is preserved by means of the horizontal rudder in the same way as when steering a course on the surface, but with this difference that even small deviations from the given course line (depth) are not here permissible. For guidance in steering a depth gauge and a clinometer are used. Steering in the vertical plane requires considable skill and experience.

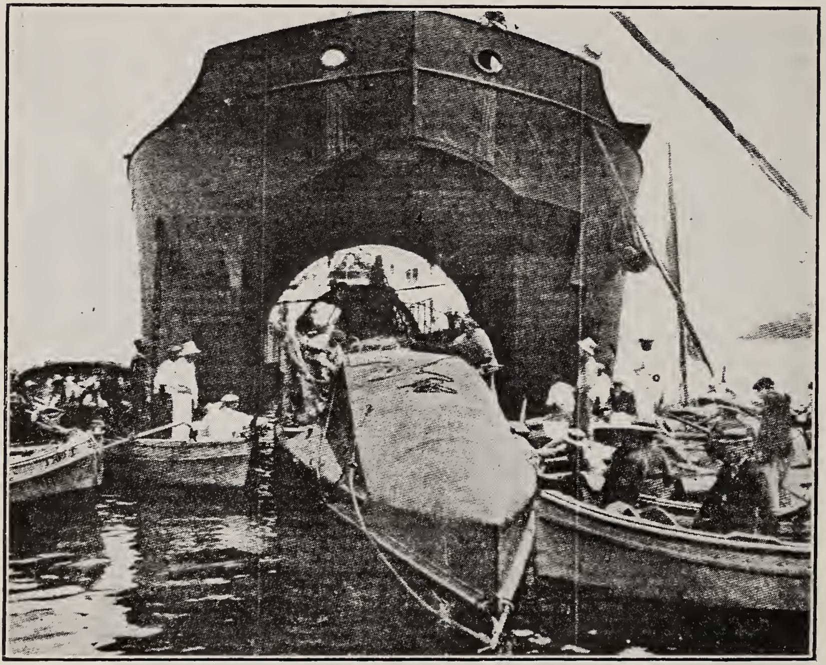
In order to navigate, the submarine boat must be provided with a reliable compass and, even when submerged, a view of the horizon must be obtainable at any time. An ordinary magnetic compass is not quite reliable even when placed in a conning-tower of bronze, but recently the advent of the gyro-compass has provided a means of accurately determinating the direction independent of magnetism. The faculty of vision when the boat is submerged, as it must be when making an attack, constitutes one of the most important and difficult problems connected with submarine boats. The water is practically opaque and it was therefore necessary in early boats, when going under water, to emerge from time to time so as to obtain a view from the conning tower, but evidently this mode of navigation was anything but safe since the presence of the boat was thus revealed to the enemy. Already in the eighties and nineties optical tubes were introduced of simple construction, invented by Marié Davy in 1854 and gradually perfected. In its simplest form the optical tube had a mirror at each end inclined at 45° to the axis. The tube, being fitted watertight in the top of the boat, projected a few feet above water when the boat was immersed and thus a view of the horizon might be obtained, but the arc of vision was at first only one or two degrees, and the image was very imperfect. The mirrors were replaced by prisms, lenses were introduced, and during the nineties several improvements were made, but not till about ten years ago was any serious progress made. Then, in a few years the optical tube or "periscope," as it is now usually called, was developed to a high degree of perfection, enabling the submarine boat to perform attacks without showing anything but the top of the periscope occasionally above water, at the same time obtaining a perfect view of the enemy. The improvements comprise a larger field of vision spanning an arc of more than 50°, as large or greater than that of the human eye, convenience of observation, and the addition of means for measuring distances and indicating directions. The magnification of the object is only about 1.5, which is found to give to the observer the same impression as when using the naked eye. By using the utmost refinements of optical art and science a perfect image of unsurpassed clearness and distinction is obtained. Mechanical power is employed for handling the tube, enabling it to be pushed up and down readily and quickly and to be turned round its axis. The length of modern tubes is up to 25 feet with a diameter of about 6 inches. The head of the tube projects from 10 to 20 feet above the hull. Difficulties still exist due to the vibration of the periscopes and spray on the front glass, but they are of secondary importance. Instruments have been constructed by which an all-round view of the horizon can be obtained without turning the tube, but have not proved quite satisfactory. The perfection of the periscope was the last link in the chain of inventions and improvements that were needed to endow the submarine boat with positive military value.

In order to go from the light to the submerged condition and vice versa it is necessary to admit or to discharge water. Main tanks of great capacity must therefore be fitted, provided with large sea-valves and powerful pumps. The water may if desired be forced out of the tanks by compressed air. The time occupied in passing from the surface to the submerged condition should not be more than about from four to five minutes. This, of course, is a point of great military importance. When a boat is completely submerged the main tanks are always entirely filled, and its weight is generally so adjusted that it falls a little below the buoyancy, leaving a tendency for the boat to rise to the surface. This tendency is overcome dynamically when the boat is in motion either by a slight inclination of the axis or by hydroplanes. The fine adjustment of the buoyancy takes place by means of a central auxiliary tank of moderate capacity used to compensate for incidental disturbing causes, such as variation in the specific gravity of the sea-water or consumption of stores. Smaller tanks near the ends of the boat permit an adjustment of the trim. Special tanks are fitted for compensating for such definite changes in weight as when a torpedo is fired and another inserted in the tube. A considerable amount of buoyancy can be obtained almost instantaneously by the release of of a safety-keel consisting of detachable blocks of lead ballast which are let go in case of emergency.

The superstructure which is above water in the light condition is self-bailing. In some boats it is built entirely and permanently open, serving only to provide a raised platform, but in most boats it is a watertight structure provided with large and numerous valves that can be readily closed when the boat is in light condition whereupon the superstructure will add to the reserve buoyancy and the stability.

## HABITABILITY

Space is always restricted in a submarine boat. When going on the surface the motor gives off much heat and requires a great amount of air for its combustion, carbon monoxide and carbonic acid, leak out from the engine. Also the men consume oxygen and produce carbonic acid, and when charging the batteries free hydrogen is liable to be liberated, forming with the air in the boat an explosive mixture and carrying with it particles of sulphuric acid. Where the fuel is gasoline or other volatile oil, it will evaporate at a low temperature and is liable to leak out into the boat; it is poisonous and capable of forming an explosive mixture with the air. For these reasons, it is necessary to provide a very vigorous ventilation when going on the surface. In the submerged condition, the problem would appear to be even more difficult because the available air is gradually vitiated, but it is found that with proper precautions



A French Transport Ship for Submarine Boats the crew can live for twelve hours or more without any sort of air renewal or means of purification. This is due to the constant leakage which takes place from the compressed air system, a leakage which can never be entirely prevented. If desired, the carbonic acid which gradually accumulates due to exhalation may be removed by chemical means or the foul air may be pumped out. Fresh air can be supplied as desired from the compressed air reservoirs or pure oxygen may be added. There is, however, rarely occasion for resorting to such means except in case of serious accident. A greater difficulty is the escape of gasoline and poisonous fumes from the motor as well as from the battery. There is no convenient test for carbon monoxide suitable for use in submarine boats, whence it has been necessary to use white mice for indicating the presence of this poisonous gas to the effects of which these little animals are very sensitive. White mice breathe much more vigorously than human beings and will absorb carbon monoxide about twenty times as rapidly as man. Hence, long before man feels any discomfort, the mice will show symptoms of distress. When this occurs and, especially when the mice become asphyxiated, it is necessary to ascend to the surface and to renew the air in the boat.

Life on board a submarine boat is very fatiguing and for this reason the time in which a boat can stay away from its base is very limited. The crew has to be changed at frequent intervals or it must be given time to recuperate, a fact which in many cases may limit the practical endurance of the submarine boat more than the supply of fuel. Under war conditions the crew of a submarine boat ought probably to be relieved after a few weeks' service, depending of course on the size and design of the boat and on the climatic and military conditions.

## Means of Propulsion

For propulsion on the surface the gasoline motor was the first really successful engine. It was light, occupied small space as compared with the steam machinery and the combustion of fuel oil was not more than about one-half pound per H. P. hour as against at least 1½ pound per H. P. hour for steam machinery. For small boats, of a displacement of from 100 to 300 tons, where weight and space were very restricted, the gasoline engine offered the best solution, but the dangers from this volatile oil soon made it necessary to introduce heavy-oil motors, although they were in several respects inferior to the gasoline motors. While the latter are easy to start, special means are required for starting the former, and the consumption of fuel in heavy-oil motors such as those of the Koerting type was about twice as great as in the gasoline motors. The last step in the development was the introduction of the Diesel engine which likewise burns heavy oil. Although in itself rather heavy, it has a consumption of fuel somewhat less than that of the gasoline engine, and this is its principal advantage. The nominal radius of action of recent boats of the largest size, driven by Diesel motors, is given as about 3,000 miles. The speed on the surface has attained

16 knots in several boats and the designed speed in some boats now under construction is 18 or 20 knots.

The Diesel engine, then, is the motor which today finds most favor in submarine boats, but with the increasing size of boats and the claims to higher speed it becomes increasingly difficult to produce motors of this type of sufficient power. Units of from 1,300 to 1,500 H. P. with a power per cylinder up to about 200 H. P. are under construction and there are usually two and in some boats three propellers. Many difficulties are met with and failures have occurred whence steam power has been preferred in some boats as for instance in the French submersibles Gustave Zédé and Nereide of 1,000 tons displacement, which are to make 20 knots. Steam machinery has the advantages of reliability and durability, but it occupies more space and it is difficult to get rid of the heat. The radius of action obtainable with steam power on a given supply of fuel is much smaller than with Diesel motors. The weight of Diesel engines as fitted in submarine boats is about 65 pounds per H. P. as compared with about 50 pounds per H. P. for gasoline engines and from 50 to 60 pounds per I.H.P. for steam machinery inclusive of auxiliaries, propellers and shafts. The Diesel engine is being steadily improved and will no doubt be successfully adapted for larger powers in the submarine vessels of the future, but as the size and power increase, the relative advantages of steam machinery will become more pronounced.

For underwater propulsion, electric power derived from a storage battery of lead accumulators still offers the best solution. Since the first appearance of these cells they have been improved upon in many technical details, and are now reliable and durable. They will stand complete charging and discharging more than 400 times and may be expected to last about five or six years under ordinary service conditions in peace time, provided they are carefully handled. The weight per H. P. hour including outfit is by discharge in 3½ hours about 80 pounds, practically the same as in the early accumulators. Lead cells permit great variations in power and are at their best at low rates of discharge, a most valuable quality for submerged work. They can be stowed low in the boat and add thus considerably to the stability. They occupy about .4 cubic feet per H. P. hour, i.e., less than any other source of energy at present available for this purpose.

Attempts have been made to introduce accumulators of different type, the most promising of which are the Edison alcalic iron-nickel cells which have now come into serious competition with the lead cells and are to be tested in practical service on board some of the United States submarine boats. Before the result of this experiment is known, it is difficult to judge of the relative merits of the two types. It seems certain, however, that the Edison cells are more durable but more costly than the lead cells.

The total accumulated energy by storage batteries is necessarily small and rarely allows more than a speed of about 10 knots for 3 or 4 hours. Recently boats have been designed for 11 or 12 knots, The radius of action at maximum speed of large boats is about 30 or 40 miles, but at reduced speed a radius of about 100 miles is claimed for some boats.

The electro-motors including switch-boards and leads weigh about 80 pounds per H. P. The excessive weight of the plant for underwater propulsion is the more unfortunate, since the weight available for propulsion is already very small as compared with that in ordinary torpedo-boats. The reason for this is that the hull weight is relatively great, occupying about 10 per cent. more of the total displacement than in a torpedo-boat. Only about 40 per cent. of the displacement of a submarine boat can be devoted to machinery and fuel as against about 50 per cent. in a torpedo-boat. Moreover, the plant for underwater propulsion comes as an extra addition and is practically a dead weight when the boat is going on the surface. It is evident, therefore, that submarine boats can never compete with ordinary torpedo-boats in point of speed.

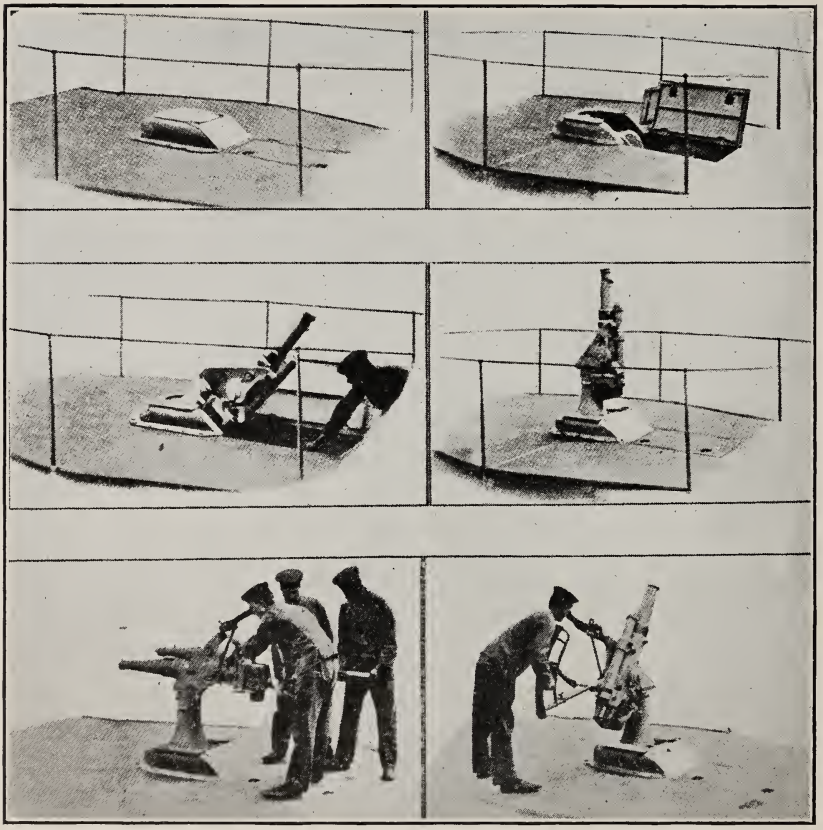
Great efforts are being made to devise a type of machinery that can be used both on the surface and submerged and especially one by which the propulsion under water does not entail any extra weight, but no satisfactory solution has yet been obtained. Any process based on combustion involves the storage of atmospheric air or oxygen, but a storage of these gases in sufficient quantities for underwater propulsion requires excessive weight and space. The discharge of the products of combustion is liable to reveal the presence of the boat.

M. d'Equevilley has proposed a solution, which is being tried in the French submersible Charles Brun and probably also in a German boat. He uses an ordinary boiler with oil fuel and a steam engine on the surface, but when the boat dives under water the exhaust steam is led to a concentrated lye of sodic hydrate which absorbs the steam under strong evolution of heat and thus serves as fuel in a secondary "soda boiler." This process goes on till the lye is saturated. When the boat comes to the surface and steam is available from the primary boiler, the soda lye may again be concentrated by evaporation of the water which it has absorbed, and the boat is ready for another submerged run. This plan offers the advantages that there is no change of propelling motor, the same engine being used under water as on the surface, and there are no products of combustion. The machinery can be forced without difficulty and relatively high power attained both in light and submerged condition. No electric motor is needed. On the other hand, the system requires the addition of special soda-boilers and a hot water reservoir; the plant occupies so much space that the available weight cannot be fully utilized; the centre of gravity of the machinery is high and requires extra ballast to be carried; the radius of action on the surface is necessarily smaller than with an explosion motor, and there is likely to be a strong corrosion of the boiler due to the soda. The soda-boiler installation appears, nevertheless, more promising than other power plants so far proposed for this purpose.

## Armament

The principal armament of submarine boats is the Whitehead torpedo. Recent English boats are said to carry six 21-inch tubes and French boats of the latest type eight tubes. Modern large boats are equipped with an armament of light guns in disappearing mountings. English boats carry two 3-inch or 4-inch guns so mounted that they can be used against air-craft as well as against other vessels. When not in use the guns and mounts are housed in the superstructure.

Attempts have been made to design mine-laying submarine boats, a problem which is evidently of considerable interest. As far as known, Russia was the only power that, prior to the war, had built a boat for this purpose, viz., the Krab, designed for dropping mines when in surface condition. It appears that the Germans are now following the example of Russia. A boat so designed that mines could be dropped when in the submerged condition would be



Disappearing Gun

of greater value, but there are technical difficulties in releasing mines under water, in compensating for their weight and in determining their exact location. These difficulties have apparently not yet been overcome.

The faculty of communicating with other vessels, whether on the surface or submerged is one of great military importance for the submarine boat. For service on the surface wireless telegraphy has been successfully used for several years, but for submerged service it is only quite recently that means of signalling have been devised which promise good results. It was at first, when the submarine bell was invented, attempted to use it for signalling, but it was found that it was not well adapted for sending meassges by the Morse system. No practical solution was discovered till an European physicist showed the way by his experiments on the transmission of vibrations through water. A wire of two inches in diameter was set into longitudinal vibrations by the friction of a hand-driven silk-wheel moistened with alcohol whereby a clear and sustained note was produced, capable of being sent in dots and dashes of the Morse code. The wire was fastened to a plate in contact with the water, and was anchored at the other end to some fixture. The tension of the wire was immaterial. An identical apparatus was fitted in one of the United States submarine boats in 1911 and readable signals were transmitted over a range of two miles. Still better results were obtained with steel ribbons and power driven exciters, by means of which distinct signals were transmitted over a distance of ten miles. Recently electrically worked oscillators have been used instead of the wire ribbons and have given very promising results. This mode of signalling is referred to as the "submarine wireless system," but it must be distinctly understood that the transmission through the water takes place entirely by sound waves emanating from a diaphragm plate which may form part of the ship's side. The receiver is a similar plate in another ship similarly connected. The invention seems now to have passed the experimental stage and signals have been transmitted under water without difficulty through a distance of fifteen miles.

As a consequence of the numerous and serious accidents which have befallen submarine boats of recent years much has been done to increase the safety of this craft. The hull is subdivided more minutely than formerly by bulkheads of sufficient strength to withstand the maximum water pressure. A buoy provided with telephone connection is fitted in the superstructure and can be sent to the surface in case of emergency, enabling communication to be established with the outside world. In some boats the men are provided with diving suits and helmets enabling them to escape or to remain for a longer time in the boat when it is flooded. Great precautions are taken to prevent the fumes from the storage battery entering the working rooms of the boat. The battery is in many boats placed in an entirely separate airtight well-ventilated compartment.

Vessels of special type, "salvage docks," are built for the purpose of raising the boats when they have sunk to the bottom in damaged condition. Shackles are fitted on the top of the boats for this purpose.

Special vessels are constructed also for the transportation of submarine boats.

From the moment that submarine boats were taken into practical service, claims to increased sea-going capability, speed, radius of action, and better living conditions on board were advanced by the naval officers. Those claims could be best met by an increase in size and we can understand, therefore, that size has steadily increased ever since the beginning of the century. Boats were then less than 100 tons fully submerged and are now being built of about 1,200 tons' displacement. The reason why the displacement has not increased much faster is chiefly the difficulty of providing suitable motors for propulsion of sufficient power. By an increase in size, moreover, the boats become more difficult to handle under water, especially where the depth is small, but this difficulty is of secondary importance for ocean-going boats, which are likely soon to become a reality. The high cost of large boats will restrict their number, the price per ton being almost three times as high as for battleships.

## Military Value

The great military value of submarine boats has been demonstrated in the European war. At the present stage of development submarine boats afford not only the best means of defence of one's own harbors and coasts, but may be used also for offensive purposes in the open sea and on the coast of an enemy up to a distance of at least five hundred miles from their base. The large boats of from 1,000 to 1,200 tons' displacement now under construction will have a still greater effective radius of action.

It is characteristic for the submarine boat that, once it has gotten into position, it can carry out an attack with relatively small risk to itself. In this respect it differs radically from ordinary torpedo-boats which must be prepared for great and almost unavoidable sacrifices in order to carry out a successful attack. The greatest difficulty with a submarine boat is to bring it into position for attack because the speed is relatively slow. The initiative of the commanding officer, the training, endurance, and discipline of the crew, as well as the condition of the boat and the machinery count more in submarine boats than in other warships.

The development of the submarine boat in the future is likely to be gradual. In the meantime, it is probable that also the means of attack and defence possessed by the battleship against submarine attack will progress. Evidently, the first point for the battleship is to detect the submarine boat before it has reached within striking range. If this is successfully accomplished, the attack of the submarine boat can generally be avoided because its speed under water is relatively slow. Detection of a submerged boat is, however, a difficult matter, the only visible point being the head of the periscope which needs to be shown above the surface only from time to time. In still water the periscope is fairly visible by the wake which it makes on the surface when emerging, but in rough and misty weather it is extremely difficult to see. When the periscope is discovered, it will be at once subject to a hail storm of projectiles from light guns and, if it is hit, the boat will be blind and helpless. If, after that the boat shows the conning tower above the surface, it will be generally exposed to destruction by artillery fire.

Detection from seaplanes and other types of air-craft is under many circumstamces fairly easy and this mode seems to promise a great deal. These new engines of war may possibly become deadly enemies of the submarine boat by attacking it with bombs. When a boat is submerged it is quite helpless against such attack. Even very light bombs are likely to prove destructive, and since the aircraft is in no danger of counter-attack from the submarine boat, it can go very low and hitting should not be a difficult matter. The submarine boat cannot even observe a seaplane when immediately over it. A further development of the seaplane is, therefore, likely to prove extremely dangerous to the submarine boat.

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No other type of war vessel has done anything approaching the same effective work as the submarine, and from a superficial survey of the whole problem, it might be thought that this has already once and for all, solved the question of the policy which must be followed in naval design in the future. It might, for instance, be deducted that we, among other nations, must concentrate upon the construction of submarines on an enormous scale, even to the exclusion of building large capital ships. Yet it is obvious, if the matter be carefully considered, that what is undoubtedly the correct policy for one nation would be quite inadvisable in the case of another. In particular a strong naval power must always keep the offensive most clearly in view, whilst a weak naval power must necessarily rely upon defensive tactics.

Submarines, if in sufficient number, can always prevent the approach of transports, although they cannot destroy the submarines opposed to them. In fact, it seems that by a combination of a large fleet of submarines, the prolific laying of mines, and effective fort guns, it will be almost impossible for any power, however strong it may be on the sea, to allow its fleet to cover the landing of an army upon hostile shores. In other words, the submarine has added so enormously to the defensive power of any nation that in course of time an invasion by sea will become an impossibility, even in the case of those countries with a very long sea coast and a relatively small fleet.

So much has the submarine thus altered warfare that, from the purely naval standpoint, the predominant sea power could never inflict a total defeat upon a minor sea power in the sense of so completely destroying the smaller navy that a landing on a hostile coast could be effected by its aid; for even the destruction of all the submarines—a difficult enough task—would still leave the mine-fields and fort guns.

The submarine will, therefore, have a very strong influence upon military tactics in the future, and in particular for those countries which do not adjoin other countries with whom they may, under any conceivable conditions, be at enmity. It follows from this that the submarine has practically rendered Great Britain immune from invasion under any circumstances, although it should be added that our submarine fleet has not yet attained such proportions as to guarantee this condition at the present time, and when it has there is always the distinct possibility that some new method of warfare will have been developed.

Submarines cannot destroy submarines, as battleships can destroy battleships, and according to past experience it is not by any means simple for any other type of craft to bring about the destruction of submarines in large numbers. It is true we can help in this direction slightly by building an enormous number of destroyers, but, on the other hand, these are costly vessels in comparison with submarines, and the number required is so very large that one doubts if this method of attacking the submarine problem will ever be carried out on such a scale as to give security of feeling against the depredations of the submarine. The point of importance to be noticed here is that, whilst surface vessels must almost invariably act in flotillas, except, perhaps, very fast destroyers, which can escape from any slower boats, the submarine works most efficiently in single units, and this has been well shown by the recent German tactics.

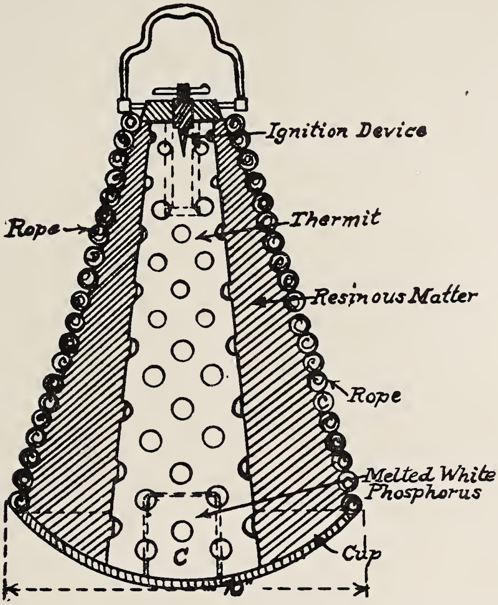
The time is already here, therefore, when we should consider to what end the path along which all naval progress is tending will lead. We must open our eyes to the dangers of the future, and make preparations accordingly, not after peace has been declared, and we find we have given away some important points, but long before the question of the terms of peace is even discussed.

We must now and onwards continue to develop submarines in this country with more urgency than ever before, and not only must much larger numbers be built in view of possible contingencies, but progress must be made with the type of submarine constructed, particularly in the matter of speed (which means progress in Diesel engine construction), and also in the possibility of under-water craft taking the offensive on a large scale.

## GERMAN INCENDIARY BOMBS

The British Fire Prevention Committee has investigated the various scenes of bomb raids in England, and has carried out tests, with the result that it has found out the nature of the bombs thrown by the aerial craft of the enemy.

An incendiary bomb is shown in section in the illustration herewith. The bomb is, as a rule, conical in shape, 10 inches in diameter at the base; it is corded around and has a metal handle at the apex. The base is a flat cup, on which a pierced metal funnel is fitted, provided at the top with an ignition device and a handle. The funnel is generally filled with thermit, which rapidly becomes molten metal, having the extraordinarily high temperature of about 5,000 degrees Fahr. This molten metal spreads upon concussion. Outside the funnel is a padding of a highly inflammable or resinous material bound on with an inflammable form of rope. The resinous material creates a pungent smoke. There is, further, generally some melted white phosphorus in the bottom of the cup which develops nauseous fumes. In some cases celluloid clippings are added, and occasionally a small quantity of petrol.



Fires caused by them, regardless of the extremely high temperature generated at the actual seat of the outbreak, may be prevented from spreading by applying water promptly, continuously, in large quantities, and under pressure.

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## LETTERS FROM GRADUATES

### WHY?

The Editor—

Sir:—The "School" spirit is the strongest sentiment in the University. (We do not like the word except for its associations. "School of Science" is apt to mislead, it may be used to mislead, to emphasise a difference between "School" science and University science). Is the life of this sentiment within the individual only of four years duration, beginning in his freshman year and dying with his graduation? Is there a "School" spirit after graduation? How strong is it? How does it manifest itself?

Should there be a "School" spirit after graduation? Of what use is it?

Yours, etc.,

A Graduate.

# THE HEAT TREATMENT OF STEEL

T. R. Loudon, B.A.Sc., A. M. Can Soc. C.E.

In the following discussion, it is not necessary to establish an elaborate definition of what is meant by "steel." A good general definition is that steel is the product of a process wherein the final metal has existed in a molten state and does not contain over 2 per cent. carbon. Such a definition may be disputed by the makers of the latest corrosion resisting "irons," but it should be recognized that these "irons" are merely steels very low in impurities. These arguments, however, need have no bearing on the following, because for all practical purposes as far as heat treatment is concerned, it is only the steels well known to commerce and always designated as such that need be taken into account. The only limitation that need be made in the discussion is that the carbon content of the metal must not exceed about 2 per cent. (theoretically 2.2%). Not that steels of such a high carbon content are of commercial value, but as will be seen, this is a rough limit that must be made if certain laws are to be applied—beyond this limit new conditions exist and the cast irons are dealt with.

Commercial steel ordinarily contains, besides iron and carbon, varying amounts of silicon, manganese, sulphur, and phosphorus, but the effects of these elements will be disregarded and the discussion limited to alloys of iron and carbon. It may be pointed out that for all practical purposes *this course of investigation may be pursued with safety as far as commerical steels are concerned.*

The effect of heat treatment on steel can only be understood when one has studied to some degree what is termed the *Iron-Carbon Diagram. It is not proposed in this article to go very minutely into the changes that take place in the constitution of steel during heating or cooling—rather merely to ouline the main changes and give the reader sufficient information to pursue the subject further should he so desire.*

## The Iron-Carbon Diagram

Fig. 1 is a Temperature-Composition Diagram—The lines on this diagram are constructed by observing at what temperatures changes take place in iron-carbon alloys of known composition. When the positions corresponding to these phenomena are plotted and joined, the diagram as given is the result. These changes are observed by means of what are called cooling curves, which are merely time-temperature curves representing the rate of cooling. The drops in temperature during stated intervals of time are noted and plotted as a curve, and it is observed that the rate of cooling changes at certain points, in some cases the temperature remaining constant during quite an interval of time. For instance, it is found that when molten metal begins to freeze, quite a change in the cooling curve is seen. In the solid state as the metal cools, other changes in the curve are noted, which on investigation are seen to represent certain internal adjustments which are of the greatest practical importance. It is usual to investigate alloys while cooling, but the changes noted during cooling will take place in the reverse order during heating, although the temperatures at which they take place are generally not quite the same as when cooling.

Applying to steels the method of investigation just described, if iron-carbon alloys of various known compositions be taken and melted and allowed to cool and the temperatures at which freezing (solidification) begins noted and plotted on a temperature-composition diagram, the lines $AZ$ and $ZP$ will result. Carrying the investigation a little further and noting the temperatures at which these same alloys are quite solid and plotting these temperatures on the ordinates representing the alloys to which they belong, the lines $BX$ and $XZ$ are obtained. To illustrate this, consider a steel of 1.5% carbon whose temperature line is represented by the ordinate $QT$ drawn from 1.5% carbon on $OW$. This steel will be molten at any temperature above $Q$. At $Q$ the metal begins to freeze and will continue to freeze till the temperature corresponding to $R$ is reached, when the metal will be entirely solid. Reversing the process, the metal would begin to melt at the temperature corresponding to $R$ and would continue to melt till the temperature corresponding to $Q$ is reached, when all the steel will be molten. This illustrates roughly the freezing or melting of any iron-carbon alloy. To sum up; at the lines $AZ$ and $ZP$ freezing begins and at the lines $BX$ or $XZ$ freezing is completed; reversing the process, melting begins at $BX$ or $XZ$ and melting is completed at $AZ$ and $ZP$. It is seen from the diagram that low carbon steels do not melt as readily as high carbon steels and that the cast iron containing about 4.3 per cent. carbon has the lowest melting point of all steels and cast irons.

It is well known that steel is not homogenous. The solid metal contains several constitutents to which names are given just as mineral constitutents are characterized one from another. The constituent that first forms when molten steel freezes is called *Austenite*, so that when the steel has entirely solidified after the freezing process, the whole mass is Austenite. The question, of course, arises as to what is the composition of this Austenite. There are two outstanding theories at present as to this composition; one maintaining that Austenite is a solid solution of iron and carbon; the other, that Austenite is a solid solution of iron and iron carbide, the carbon having formed a carbide of iron which in turn forms a solid solution with the remaining iron. The discussion of the pros and cons of these theories are of little practical interest. In the following, Austenite will be considered as a solid solution of iron and iron carbide, this carbide being represented by the formula $Fe_3C$. The term solid solution may be new to many and in consequence may cause a little confusion. The idea of one substance dissolving in another when liquid, is, of course, quite familiar. The term solid solution merely represents the fact that one substance dissolves in another when both are in the solid state.

Austenite, then, is a solid solution of iron and iron carbide. However, it is usual to give these two constituents distinctive names. Pure iron is referred to as *Ferrite* and iron carbide ($Fe_3C$) is called

*Cementite*, so that hereafter, *Austenite will be referred to as a solid solution of Ferrite and Cementite.* In order to investigate the changes that take place in the constitution of steel during cooling, it is advisable to take certain examples which are typical and follow out their cooling.

Considering first a steel containing, .2 per cent. of carbon, the changes that take place will be typical for all steels containing from zero to about .4 per cent. carbon. The cooling of this steel is represented by the line *A.E*, Fig. 1. At *A*, freezing begins with the formation of Austenite. At *B* the metal is all solid Austenite. When the temperature corresponding to *C* is reached, Ferrite begins to segregate out of the Austenite and as the temperature drops from C to E more and more, Ferrite separates out. This ferrite that separates out is called *excess Ferrite*. At *E*, the remainder of the Austenite formation which now contains all the cementite, breaks up into its constituents, namely, Ferrite, Cementite, these two constituents forming in small plates side by side. This portion of the steel which breaks up into the formation last described is called *Pearlite*,

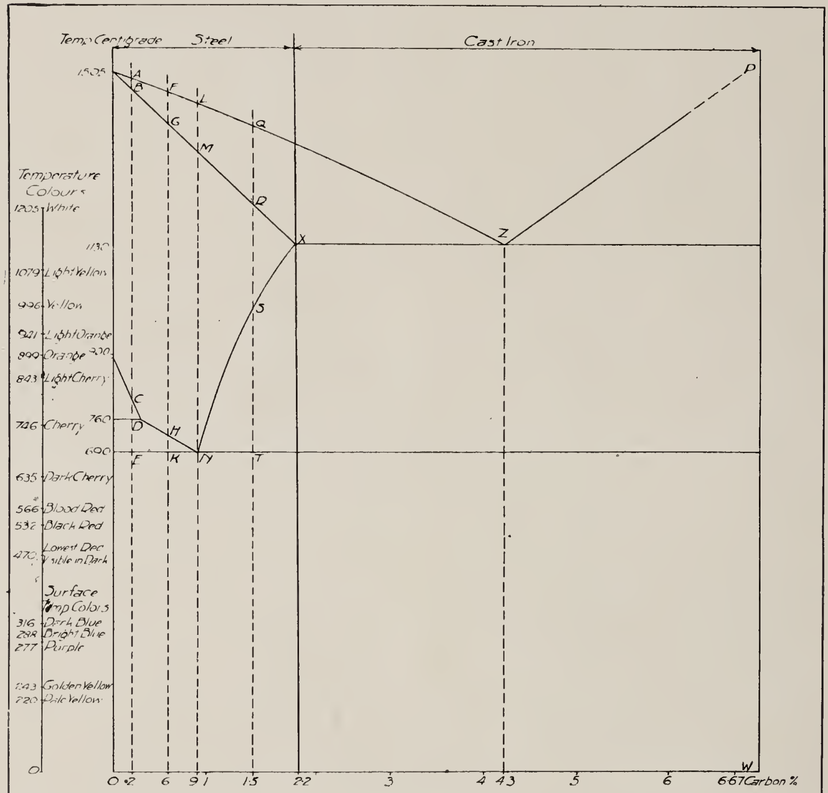

FIG. 1.

which we see is a formation of Ferrite and Cementite. The steel at *E*, therefore, is made up of small areas of Pearlite (Ferrite and Cementite intermingled with one another) surrounded by excess Ferrite which segregated out during the cooling from *C* to *E*.

As intimated before, it is the writer's intention to keep out as many of the intricacies as possible, but it will no doubt have been noticed that in following out the cooling of the above example of steel, that there was some change at *D* of which no mention was made. *Above D, the steel is non-magnetic, below D, the steel is magnetic.* Another allotropic change takes place at *C*, but this need not be discussed here.

Taking next a steel containing .6 per cent. carbon we have a sample typical of all steels containing between about .4 per cent. and about .9 per cent. carbon.

At *F*, Austenite begins to form and at *G* the metal is entirely solidified. At *H* the steel becomes magnetic and the excess Ferrite begins to segregate out of the Austenite. Between *H* and *K* the excess Ferrite continues to separate out; and at *K*, the remaining Austenite breaks up into its constituents, Ferrite and Cementite, giving the formation called Pearlite. The steel thus at temperatures below *K* is Pearlite surrounded by excess Ferrite.

With a steel containing about .9 per cent. carbon, solidification takes place between *L* and *M*. At *N* the steel becomes magnetic and the Austenite all becomes Pearlite.

The transformations for a steel containing 1.5 per cent. carbon will be typical for steels containing from about .9 per cent. to 2.2 per cent. carbon.

Between *Q* and *R* Austenite is formed. At *S*, on the line *XN*, Cementite begins to segregate out and continues to do so during the cooling from *S* to *T*, this Cementite being called *excess Cementite*. At *T*, the remaining Austenite becomes Pearlite. The steel below *T* is Pearlite surrounded by the excess Cementite.

It will be noticed that steels containing below .9 per cent. carbon are made up of Pearlite surrounded by excess Ferrite. Steels containing above .9 per cent. carbon are Pearlite surrounded by excess Cementite. Steel containing .9 per cent. carbon is all Pearlite, from which one would suspect that Pearlite by itself contains .9 per cent. of its own weight of carbon. This is true. When a steel has less than .9 per cent. total carbon, the Ferrite in the Austenite separates out by itself till the remaining Austenite contains .9 per cent. of its own weight in carbon, whereupon it changes to Pearlite. In steel containing over .9 per cent. carbon the Cementite separates out by itself taking with it considerable carbon, and when the remaining Austentite contains .9 per cent. of its own weight in carbon, it also changes into Pearlite.

From the foregoing, it is seen that steel contains two main constituents, Ferrite and Cementite, which group themselves in various ways to give the normal steel. Ferrite, being pure iron, is very ductile. Cementite on the other hand is extremely hard. Pearlite is a mixture of both Ferrite and Cementite, and one would expect it to be strong and yet fairly hard. Taking these facts and applying them to the analysis of the physical properties of steels, one sees why low carbon steels containing as they do, a considerable quantity of excess Ferrite, are very ductile. As the carbon content of the steel grows, the steel contains more and more Pearlite and in consequence becomes higher in tensile strength but loses in ductility due to the lessening proportion of Ferrite. After .9 per cent. carbon is passed, the excess Cementite makes the steel harder and more brittle, the tensile strength also dropping off.

It must be clearly understood that the changes outlined throughout the above are those that take place under normal cooling. In other words, a piece of steel must be allowed to cool at a fairly slow rate if the normal conditions in the steel are desired. *Interference with the rate of cooling, such as chilling, for instance, will greatly effect the properties of the steel.*

## THE GRAIN SIZE OF STEEL

The granular structure of steel is best seen by observing a polished section under the microscope, although it is possible to get a comparative idea by observing the fracture, especially in the high carbon steels. Overheating steel above a certain temperature has a great effect on the grain size, and as grain size is more or less a direct indication of the strength and ductility of steel, it is important that the cures for overheating be understood.

The higher a piece of steel is heated above about 690°C. the coarser will be the grain size. (It may be pointed out that normally the grain size of low carbon steels is larger than high carbon steels). This coarsening of the grain size by overheating has the following effect: Low carbon steels lose in strength but do not seem to have their ductile qualities effected materially.

Medium and high carbon steels lose both in strength and ductility. Tool steels, for instance, when badly overheated become so weak as to be readily broken if tapped very lightly with a hammer.

The effect of overheating may be counteracted in two ways:—

(1) Work the steel mechanically as it cools from a high temperature.

(2) Heat refine the steel.

To apply the mechanical method, the steel must be forged or rolled as it cools. The effect may be roughly explained by saying that the forging or rolling breaks up the coarse grains. The mechanical work should theoretically be kept up till the steel has cooled to the temperature of the lines *C H N T*, Fig. 1, for if stopped at a temperature above this, the grain size will grow again till these temperatures are reached. The effort of engineers is to get the steel manufacturer to have the temperature at which rolling is completed as close as possible to these temperatures. In many cases, there is no doubt that the finishing temperature of rolling mills is too high, the result being a coarse grained and weakened steel. With forging, on the other hand, the work is generally continued to a lower temperature, as a forge hammer does not require as great an expenditure of energy and consequently money, to produce the required effect as does a rolling mill.

If a piece of steel has been overheated and allowed to become cold, and it is desired to restore the grain size mechanically, it is only necessary to reheat the steel and forge or roll it.

It is seen that besides shaping a piece of steel, rolling and forging has another very important function, namely, *the production of strength by reducing the grain size of the steel.*

Obviously, there are many commercial steel shapes that do not lend themselves to work being done on them by either rolling or forging. Steel castings, for instance, furnish a good example. Many structural shapes also may be overheated subsequent to their manufacture, and in order to restore their grain size it would be impossible to forge them, much less roll them again. So then, if the grain coarsening effect of overheating is to be overcome, some other method must be resorted to. This other method is known as Heat Refining. In order to heat refine the grain size of a piece of overheated steel, the metal must first be cooled below 690°C. For low carbon steels from zero to .7 per cent. carbon, reheat the steel till the line $C\ H\ N$ is reached. For high carbon steels from about .7 per cent. carbon up, reheat to about 725°C. The effect of this reheating is to break up the original coarse grain size and produce a new fine grain formation. Researches show that if a piece of steel be allowed to cool below 690°C., that on reheating a new grain formation starts on recrossing the temperature 690°, and this new formation of small grains will obliterate the old formation of large grains. This is a rough explanation, but it contains the principle of the process. As to the reason why the lower carbon steels have to be reheated higher than high carbon steels this would require more space for explanation than is at our disposal. The best practical example of the application of heat refining is seen in the heat treatment of steel castings. If it is necessary to make a low carbon steel casting of good ductility, it is usual to "anneal" it. Strictly speaking, "to anneal" means to slowly cool, but it is easily seen that *any amount of slow cooling will not refine the grain size.* A steel casting on cooling is extremely coarse grained, having cooled from a very high temperature above 690°C. In order to get a fine grained casting, it is always necessary to first cool below 690° and then reheat as explained above. Eye-bars for bridges are also often heat refined to make sure that the steel is as ductile and strong as possible. It is not out of place to point out here that there is a curious and persistent fallacy often expressed even to-day; namely that "vibration or shock will crystallize a piece of steel." There never has been any evidence that the grain of steel is coarsened by such treatment and to suppose that such treatment produces steel of a granular structure is an absurdity. Steel is always granular in formation. As to the growth of grain size due to such treatment, it is more than likely in every such case that the steel was coarse grained due to faulty manufacture and this fact was only discovered when the fracture occurred.

Generally speaking, no growth of grain size takes place below 690°C. However, there seems to be one exception to this in the case of very low carbon steels containing below .1 per cent. carbon. These steels if held for a long time at temperatures between 500°C. and 740°C. will have the grain size enormously enlarged and the metal becomes very weak. This phenomena is called "Stead's Brittleness" after J. E. Stead, who discovered it.

## BURNING OF STEEL

The external evidence of what is known as burnt steel is seen in the peculiar sparking of the metal at high temperatures. A slight amount of surface burning may not injure a piece of steel, but in any event the effect is certainly not beneficial. *Low carbon steels can be heated much higher without being burnt than can high carbon steels* such as used in tool making.

The burning is simply an oxidation of the steel. In badly burnt steel, the grains of steel become surrounded with oxide films, thus greatly and permanently impairing the strength.

Forging seems to do away with any injurious effect when the steel is only slightly burnt. This explains no doubt, why rivets which are often slightly burnt are not badly reduced in strength. However, as the writer heard one well known steel man say, the best way to do away with the bad effects of burnt steel is not to burn it.

## HARDENING STEEL

Under normal conditions, the higher the carbon content of a steel the harder the steel. If a steel be heated to any temperature above 690°C. and cooled suddenly, it will become much harder than when in a normal condition. The rule quoted above as to the relation between hardness and carbon content also applies in this last case when cooling is accelerated. The higher the carbon content, the harder the steel will be when cooled suddenly. If the carbon content be below .2 per cent., however, it is doubtful if the increase in hardness of a steel cooled suddenly over a normally cooled specimen can be noticed by ordinary methods, such as testing with a file. Above this percentage of carbon the increase in hardness becomes more and more noticeable till the tool steels are reached.

In order to obtain the greatest possible strength with hardness, care must be taken not to heat a steel to too high a temperature above 690°C. It is true that hardening will be produced if cooled suddenly from any temperature above this, but it must be kept in mind that a high temperature above 690°C. will coarsen the grain size, thus reducing the strength. The best combined effect of hardening and strength is given at the temperatures of the line *C H N* for steels below .7 per cent. carbon and at about 725°C. for steels above this percentage of carbon.

The rate of cooling is of great practical importance when hardened steel is desired. *The faster a steel is cooled from above 690°C., the harder it will be.* Quenching in ice brine gives a very hard steel. Quenching in pure water at ordinary temperatures will harden the steel but not so much as ice brine. Quenching in oil gives a softer effect. By a judicious use of cooling medium, various degrees of hardness can be produced.

## Tempering Steel

Tempering is a term nearly always misused. To temper a steel means to lessen the effect of hardening. Generally, the hardening and tempering are both classed together and referred to as tempering. *If a steel has been hardened, it may be tempered by being slightly reheated.* To understand the principle of tempering, what takes place during hardening must be investigated.

When a steel cools at a normal rate, we have seen that certain changes and adjustments take place. If the rate of cooling be hastened, sufficient time for these changes is not allowed and a condition which is not normal is brought about and maintained, the quick cooling making the metal too rigid to allow the normal changes to take place. At least this is a very satisfactory general way of viewing the situation. If now, the steel is slightly reheated, the rigidity of the metal is loosened and the normal changes will either be wholly or partly brought about, depending upon whether or not the steel be again quenched, thus again stopping the changes which may be taking place.

To summarize the tempering process; if a steel has been hardened, it may be either partially or wholly softened by reheating. The effect of this reheating may be stopped at any stage by simply cooling suddenly when desired.

A very convenient method of judging to what temperature a piece of steel has been reheated for tempering, is my means of observing the temper colours. If the surface of the steel be slightly polished it will be noticed that oxide colours form between 200°C. and 300°C. The temperatures corresponding to these colours are shown on Fig. 1. It is not necessary to reheat beyond any of these temperatures in order to temper a steel.

It may be pointed out that quenching in liquids, such as oil, which takes away heat slowly, gives practically the same effect as may be had by quenching in water and then tempering. When heat is abstracted by the oil, it is not taken away at such a rate as to entirely stop the normal changes from taking place. Cold water on the other hand, may almost entirely stop these changes, but the tempering allows them to slightly take place, thus arriving at the result obtained by oil hardening.

To illustrate the hardening and tempering of a cutting tool, the cold chisel gives a very good example. About one and a half inches of the tool are heated to a cherry red and then one half of this heated portion is quenched in water. The heat from the remainder is then allowed to flow into the quenched and hardened portion, thus tempering it. If the temper colours be observed, the yellow will be seen moving slowly down to the point and the blue will be a short distance behind. This indicates the temperature of the steel and when these colours have gone far enough down the metal, the tool is quenched. Thus a good hard cutting edge may be obtained with the steel grading back to normal tough metal. The natural question at this stage is, when should the tempering be stopped? A very few trials will give the needed experience. If a cold chisel be taken and experimented with, the reader will very soon be able to judge for himself when to stop the tempering operation in order to get the proper hardness and toughness.

For rough work, the colours of the steel for given temperatures are shown on Fig. 1. This method of judging temperature by the eye is, of course, only good for rough work. When accurate results are required, pyrometers are used, and indeed, to attempt any other method would be out of the question.

## PERSONALS

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**J. Chalmers, '94**, has been elected an officer of the Edmonton Branch of the Canadian Society of Civil Engineers for 1915-16.

**Norman S. Caudwell, '10**, of the town of Prescott and solicitor of the Supreme Court, has been appointed notary public in and for Ontario.

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# MODERN MILITARY EXPLOSIVES

J. W. Bain, B.A.Sc.

The most casual reader of the newspapers must have noticed among the despatches from the front, such items as, "The French fired 30,000 shells in a two hours' attack," but it may be stated with certainty that few of those who glance over the reports have any idea of the elaborate preparation which must be undertaken before the shell is sent upon its death-dealing mission. Not only must the shell be very accurately made as far as dimensions and weight are concerned, but it must be propelled and burst by the use of materials which demand a tedious and very careful manufacture. It may not be out of place at this time to discuss these modern military explosives, during which brief discussion it is hoped that certain outstanding facts may be emphasized.

Gunpowder as it has been known to Europe for the last five hundred years, plays a minor part in the present conflict

The smoke which accompanies its explosion has a very obvious drawback from a military standpoint, and the concealment of guns, so strikingly shown in many illustrations recently published, has been rendered possible by the use of smokeless explosives. With the exception of small quantities of gunpowder used in the fuse of a shell and as a bursting charge in shrapnel, the powder of our fathers' days may be said to have been abandoned.

As a propelling charge in guns and rifles of all sizes, smokeless powders are almost universally used. These are mixtures of gun-cotton, nitroglycerine and a thick mineral oil such as vaseline; and a few words may be said as to their manufacture.

That an explosive oil could be obtained by mixing glycerine with nitric and sulphuric acids has been known since 1847 when an Italian chemist discovered the fact accidentally.

This substance, nitroglycerine, was, however, too dangerous to handle in its liquid condition, and Nobel conceived the happy idea of absorbing it in some porous material producing the familiar explosive, dynamite. The shattering property of the latter is well known to every one, and this material is consequently of no value as a propelling agent in a gun.

It was, however, discovered in recent years that if gun-cotton—which will be discussed later—were kneaded with nitroglycerine in the presence of a small quantity of acetone or camphor, there resulted a doughy mass which could be handled safely and at the same time worked up into a valuable propellant, exploding without smoke.

This is, in brief, the process of manufacturing the British *Cordite*, so-called because the dough is squeezed through dies under heavy pressure and reeled into cords which are afterwards cut to convenient lengths. The diameter of these cords is varied to suit the use for which the powder is intended, the larger the gun, the thicker the cord, and in some instances, the mass is moulded into large prisms or cylinders.. Powders of this type varying slightly in composition, size and method of manufacture are used by all the present combatants, and the supply must be adequate, or a retreat such as the Russians have just made is inevitable.

For the bursting charge in high explosive shells, picric acid or trinitrotoluol are the most widely used. Picric acid is obtained by the action of nitric and sulphuric acids upon carbolic acid, the latter a product of the distillation of coal tar. Under ordinary conditions, a yellow powder burning quietly in the open, melts at 122°C, and may be poured without danger in the shells where it solidifies as a dense yellow mass; such shells may be handled without special precaution and are prepared for use by the addition of a fuse. This consists of a somewhat elaborate timing device containing a thread of gunpowder which burns at a definite rate and leads to a small quantity of fulminate of mercury, which detonates violently on heating. The picric acid is curiously sensitive to such detonation and explodes with the greatest violence, liberating quantities of yellow fumes which are frequently referred to.

Trinitrotoluol is prepared by the action of nitric and sulphuric acids on toluol, a liquid hydro carbon, which, like carbolic acid, is a product of the distillation of coal tar. Trinitrotoluene burns quietly with a smoky flame, and only explodes violently when detonated with fulminate of mercury. It melts at about 80°C and can, consequently, be handled more conveniently than picric acid which melts at 122.5°; the latter has the additional disadvantage of emitting quantities of yellow, acrid fumes during the fusion which renders the loading process very unpleasant. Picric acid has also the drawback that it forms with many metals, highly explosive salts, so that for safety sake, the interior of the shell must be varnished, and the explosive is further protected by a paper lining. Trinitrotoluol does not suffer from these disadvantages. It may be interesting to note that the Dominion Steel and Iron Company at Sydney, B.C., are turning out about 500 gals. of toluol per day for the manufacture of this explosive, the final stages being carried out elsewhere; as far as the writer is aware, no picric acid has been made as yet in Canada.

For the destruction of bridges, earthworks, masonry, etc., and as a charge for torpedoes, gun cotton is widely used. This is made by the action of nitric and sulphuric acids on cotton, the product resembling closely the original fibrous material. After a very thorough washing, it is compressed into blocks and stored with a content of about 17% water. Like the two explosives mentioned above, it is fired with a fulminate charge; commonly a small amount of dry gun-cotton is also used, which permits the amount of the fulminate to be reduced.

These four explosives may be regarded as the most important in use at the present time; others are being employed without doubt, but their manufacture and properties cannot be considered here.

It will be noted that the raw materials used for the preparation of these four substances are as follows:

| | |
|---|---|
| Sulphuric acid, | Carbolic acid, |

Nitric acid, Toluol,
Glycerine, Cotton,

and each of these will be referred to briefly in turn.

Germany has produced in recent years very large quantities of *Sulphuric acid.* To manufacture this substance, sulphur of some sulphides are essential; the former is not found native in quantities in the territory of the Dual Alliance. There are, however, considerable quantities of sulphides; and in the newly-conquered Belgium, the Austro-Germans have acquired control of large bodies of zinc blende, an ore in common use for the manufacture of sulphuric acid. It may be concluded, therefore, that the supply of this acid is adequate.

*Nitric acid* has until ten years ago, been made exclusively from sodium nitrate imported from Chile, where it is found native. This source being cut off, the Germanic Allies have had to fall back upon the nitric acid made from the air by electric furnace methods. The latter have been highly developed in Norway owing to the cheapness of water power, but there are well founded reports current that steam power is being used in Germany for the same purpose. Taking the most favorable yields which have been made public, one horse power year will yield 1¼ tons of pure nitric acid, and Norway's total production is estimated at 300,000 tons. When the enormous plant which would be necessary to generate 100,000 horse power by steam is considered, the writer is forced to the conclusion that only a quarter or a third of the requirements of the Germanic Allies can be produced within their own territory by the processes under consideration.

Ammonia can be converted into nitric acid and without difficulty and this is being done beyond question in Germany at present. No data are at hand which permits a calculation as to the output from this source, but for various reasons which cannot be detailed, the writer believes that 100,000 tons per annum is the maximum at present.

We have then a maximum probable supply of nitric acid sufficient for the manufacture of 1,000 tons of explosives per day.

*Glycerine* is obtained by boiling the natural fats or oils with caustic soda, or by treating these with steam under pressure. In 1912, Germany imported glycerine or its equivalent in fats to the extent of 19,000 tons; the loss of these imports can only be made up by oils or fats obtained in the territories of the Dual Alliance. Here, again it is difficult to estimate the available supply, but the writer believes that a shortage in glycerines is inevitable. It is not unlikely that substitutes for nitroglycerine in the manufacture of smokeless powder, will be or are being used, and the shortage alluded to above would not have any serious effect on the supply of munitions.

*Carbolic acid and toluol*, as has already been noted, are obtained from coal tar, or from coal gas. The conversion to the corresponding explosives is comparatively easy from a chemical standpoint, and here the Germanic Powers have a decided advantage. Everyone is familiar with the great coal tar dye industry of Germany, and their great plants can be adapted for the manufacture of these explosives on a few days' notice. The same apparatus which is used in making the dyes, can with a few minor changes, be turned to the production of picric acid or trinitrotoluol, while the Allied Powers are forced to build many of their factories from the ground. The immense advantage which this has given to the Dual Alliance, shows only in more marked relief, their inability to deal the crushing blows which were to decided the issue.

Carbolic acid and toluol can be made in very large quantities in Germany and Austro-Hungary; there seems to be little prospect of the shortage in these substances. *Cotton* has been so prominent a factor in the maritime warfare that but little need be said. When the amounts of cotton in the possession of one household are remembered, it is not difficult to conclude that very large contributions can be made by private citizens should necessity arise, but here again the picture holds only the prospect of lessening supplies. Whether wood pulp or paper which like cotton, is almost pure cellulose, can be used in its place, still remains to be seen, but much can be done under stress, and gun cotton will not fail as an explosive for some time to come.

In conclusion, some data and calculations may be of interest. Sixteen cartridges for the British service rifle contain 1 pound cordite, or, 1,000,000 cartridges contain 31 tons. The French 75 mm. gun uses 5 pounds of explosives for each explosive shell; 100,000 shells involve the expenditure of 250 tons. A 12 in. British gun requires 189 pounds of explosives per shot, or 10½ rounds per ton of explosive,

The writer has amused himself in making some guesses as to the daily consumption of explosives upon the various battle fronts, with only the vague data of occasional reports as a basis. What quantities have been expended by the Germanic Allies in Galicia and Poland since May is even beyond guessing, for practically no information has appeared; we are merely informed that the consumption has been enormous. The impression which is produced in our minds is that exhaustion of the supply is approaching, but we must bear carefully in mind, that our journalists feed us sedulously with the most optimistic scraps of information, and that we have as yet no information, direct or indirect, that the Dual Alliance is failing or is likely to fail for some time to come in its supplies of explosives.

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# THE WORK OF THE ENGINEERING SOCIETY OF THE UNIVERSITY OF TORONTO AND ITS COOPERATION WITH THE FACULTY OF APPLIED SCIENCE

Dean W. H. Ellis, M.A., M.B.

The founders of the University College Literary and Scientific Society had in mind an organization for the discussion of subjects of interest to the students of both literary and scientific character, but the scientific side was always a dead letter and that body from the first became purely a debating society.

The late W. B. Murrich, M.A., LL.B., at one time president of the society endeavoured to stimulate the scientific side by giving a medal for a scientific essay, but without any permanent effect in changing the character of the Society.

In its own way and after its own fashion, the society played a very important part in university life. It afforded a means of social intercourse to the students, gave them opportunities of becoming acquainted with the conduct of public business and practice in public speaking, as well as other advantages of much value.

The students of the School of Practical Science recognized the value of such an organization and a band of enterprising and public spirited students, prominent among whom was Dr. T. Kennard Thomson, organized a society in the School in the year 1885. The first President being the Principal of the School, Professor Galbraith. Thus from its inception the Faculty and the students have been closely associated in the Engineering Society. As soon, however, as the Society was fairly on its feet, it chose a President from among the students and Mr. H. E. T. Haultain was elected to this position. From that time till now the President of the Engineering Society has been a student.

Although it has been implied that the idea of the Engineering Society was suggested by the University College Literary and Scientific Society, the former is no slavish imitation of its older sister, but was organized and has developed on quite distinct lines. It aims to be and is a professional society and its papers are all of a technical character, in most cases relating the experience of the author. A number of very valuable papers have from time to time been contributed by graduates and many good papers have been given by undergraduates, based on their vacation work.

In addition to this many useful and stimulating lectures have been given by engineers of eminence on subjects on which they were recognized authorities, thus giving the students a first hand acquaintance with the conditions of modern engineering as understood and practiced by its engineers occupying leading positions in this and other countries. The business meetings of the Society and its various committees afford to the student training and practice in the conduct of public business, which many of them have found of great value in after life.

Some years ago the Society undertook to sell to its members on the co-operative system the various instruments and materials required by students of Engineering and this Supply Department has had a flourishing career for several years.

There is one feature of the Engineering Society which calls for special notice, this is its representative character. In a very special sense the Engineering Society may claim to represent the students of the Faculty of Applied Science, in fact the Engineering Society is an embodiment of the undergraduates of the Faculty of Applied Science and can speak for them with no uncertain voice. By a wise provision the fee for membership of the Society is included in the dues payable by each student to the Bursar, and hence every student in good standing is a member of the Society.

It may be assumed therefore with more than usual confidence that a resolution of the Engineering Society expresses the opinion of the undergraduates of the Faculty of Applied Science and the most direct way of reaching the ears of the student body is through the Engineering Society.

The existence of this thoroughly representative body with a democratic organization of its own, has been and is of the greatest value with regard to the relations between the teaching staff and the students of the Faculty.

Many things that cause friction between the governors and the governed do so because of mutual misunderstanding, the saying tout savoir est tout pardonner, though not the whole truth contains more thuth than most sayings of its kind, and any thing which helps to make clear to the student what the Professors really mean and to the Professors what the students really think is of the greatest value.

Ten minutes chat between an official of the Faculty Council and an officer of the Society will often clear up misunderstandings that might otherwise have become quarrels and developed into harshness on the one side and mutiny on the other.

The Engineering Society in this way is looked upon by the Faculty Council as a most valuable ally in the task of maintaining the orderly and efficient working of the academic machinery. It is and has been a power working in the interests of peace and good will.

In addition to all this the Engineering Society publishes a journal "APPLIED SCIENCE."

This is the most ambitious and perhaps on the whole the most creditable of its many activities. The Society may point with justifiable pride to the volumes of "APPLIED SCIENCE" which have appeared since its inception in 1907. Graduates and undergraduates, professors and students have joined in the endeavour to make this publication worthy of the University and of the Faculty which it represents and their labours have been rewarded with no small measure of success. No one who knows anything of the conduct of a periodical of this kind will be surprised to learn that its upkeep makes a heavy demand on the financial resources of the Engineering Society. To keep the journal up to the standard which its promoters have had in mind demands considerable effort and sacrifice on behalf of the Faculty of Applied Science and its friends. It is to the graduates of the university in Applied Science that the executive of the Engineering Society and the editorial staff must look for support in this undertaking and they confidently expect that they will not look in vain.

# SHRAPNEL*

## Similarities and Differences in Leading Types of Shells

Shrapnel shells, as used at the present time by the several governments, vary slightly in construction and general contour as well as in the constituents entering into their different members. A completed shrapnel, as illustrated, consists of a brass case carrying a detonating primer and the explosive charge for propelling the projectile out of the bore of the gun; a projectile, which is a forged shell carrying lead bullets and a bursting charge; and screwed into the front end a combination timing and percussion fuse which can be set so as to explode the shell at any desired point and from which the flame for exploding the bursting charges is conveyed through a powder timing train and a tube filled with powder pellets down through the diaphragm to the powder pocket.

Shrapnel shells are made in two distinct types, the common, and the high-explosive. The high-explosive shell is not ruptured upon the explosion of the bursting charge in the base, but the head is forced out and the bullets are shot out of the case with an increased velocity. In the meantime, the head continues in its flight and detonates on impact. This type of shell is not used quite so extensively as the common shrapnel, and for simplicity of description the latter alone will be taken up in the following.

So far as the construction of the shrapnel shell and case is concerned, there is little difference in those employed by the various governments. The form of the explosive charge held in the brass case differs in almost every instance, but smokeless powder in some form or other is used. The detonating agent or primer held in the head of the case also varies in almost every type of shrapnel. Practically all primers are provided with "safety heads" so that the shrapnel can be handled without danger of premature explosion.

The shell itself, as previously mentioned, is made either from a forging or, in the case of American and French shells, from bar stock. Forgings, however, are used to a greater extent than bar stock, because the forged shell is more homogeneous in its structure than the bar stock shell, and piping is entirely eliminated. Near the base of all shells is a groove in which a bronze or copper band is hydraulically shrunk. This is afterward machined to the desired shape and takes the rifling grooves in the gun so as to rotate the shell when it is being expelled.

The bursting charge, common black powder, is carried in the base of the shell and is usually enclosed in a tin cup. Above this is the diaphragm which is used for carrying the lead bullets out of the shell when the bursting charge explodes and distributes them in a fan shape. In most shells, upon exploding, the nose blows out, stripping the threads that hold the members together. It will therefore be seen that, in the explosion, the entire fuse, fuse base, tube, diaphragm and bullets are all ejected, the shell itself acting as a secondary cannon in the air.

The range of a 3-inch shrapnel shell is about 6500 yards, and the

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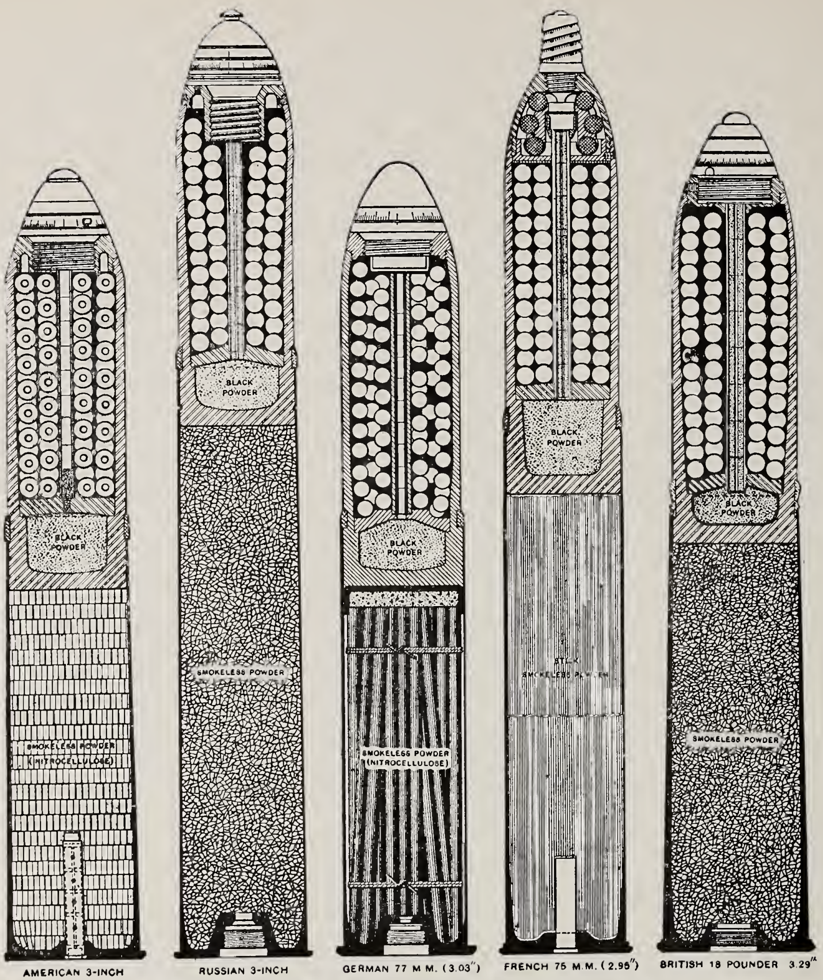
*Machinery.

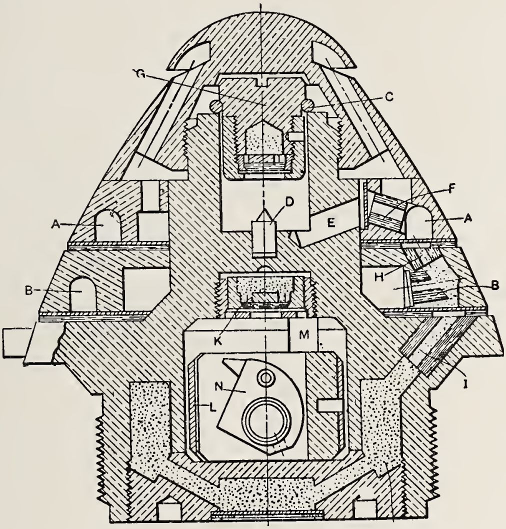


AMERICAN 3-INCH RUSSIAN 3-INCH GERMAN 77 M M. (3.03") FRENCH 75 M.M. (2.98") BRITISH 18 POUNDER 3.29"

**SECTIONS THROUGH TYPICAL SHELLS OF LEADING NATIONS**

muzzle velocity of the quick-firing field gun ranges from 1700 on the American to 1930 feet per second on the Russian. The duration of flight ranges from 21 to 25 seconds. When the bullets are blown out of the shell by the bursting charge, they are given an increased velocity of from 250 to 300 feet per second. The velocity of the shrapnel at 6500 yards is about 724 feet per second. The number of lead bullets carried in the 3-inch shrapnel shells ranges from 210 to 360. In all cases, the lead bullets are about ½ inch in diameter, weight approximately 167 grains, and are kept from moving in the shell by resin or other smoke-producing matrix.

The matrix put in with the lead bullets, in addition to keeping them from rattling, is also used as a tracer. It is of importance in firing shrapnel that the position of the explosion be plainly seen. With large shells this is not difficult, but with shrapnel for field guns at long range certain conditions of the atmosphere make it difficult to see when the shell actually bursts. Various mixtures are used to overcome this difficulty. In some cases fine grained black powder is compressed in with the bullets in order to give the desired effect. In the German shrapnel a mixture of red amorphous phosphorus and fine grained powder which produces a dense white cloud of smoke is used, and in the Russian, a mixture of magnesium and antimony sulphide is used.



American Timing and Percussion Fuse

The most common fuse is that known as the combination timing and percussion fuse of the double-banked type. This is used in practically all shrapnel fuses except the French. The manner in which the combination timing and percussion fuse is regulated to discharge the bursting charge in the shrapnel shell is interesting and involves extremely difficult mathematical calculations. Before going into the method of setting the fuse, it would probably be advisable to describe briefly just how the fuse operates. An example of the double-banked fuse is that adopted by the American government, here illustrated. The following description applies to this type of fuse.

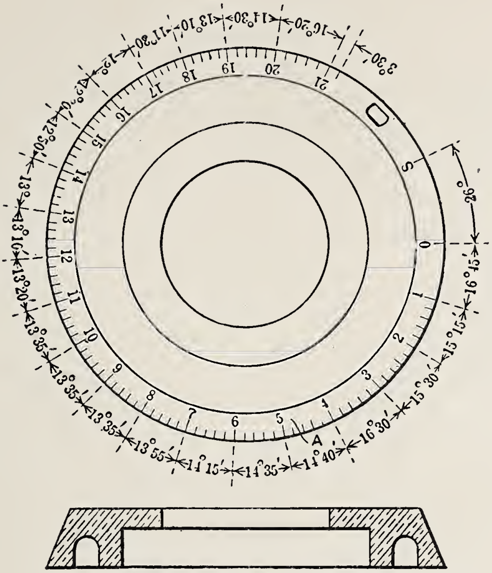
Assume first, that the timing ring is set at zero. The propelling force given to the shrapnel shell in leaving the bore of the gun is such as to sever the wire *C* from the plunger *G*. The plunger *G* carries a concussion primer which is discharged by hitting a firing pin *D*. The flame passes out through the vent *E*, igniting the powder pellet *F* and the upper end of the train A, and then through the vent *H*. From here, the flame is transmitted to the lower timing ring *B* through the vent *I* and the magazine *J*, and from there through the tube to the bursting charge in the base of the shrapnel shell.

Assume any other setting, say 12 seconds. The vent *H* is now changed in position with respect to the vent *F* leading to the upper timing train, and the vent *I* leading to the powder magazine *J* is also changed. The flame, therefore, now passes through the vent *E* and burns along the upper time-train *A* in a counterclock-wise direction until the vent *H* is reached. It then passes down to the beginning of the lower timing train and burns back in a clockwise direction to the position of the vent *I*, from which it is transmitted by the pellet of compressed powder in this vent to the powder magazine *J*. It should be understood that the annular grooves in the lower face of each timing train do not form complete circles, a solid portion being left between the grooves in the ends of each. This solid portion is used to obtain a setting at which the fuse cannot be exploded and is known as the "safety point." As shown it is marked *S* on the adjustable timing ring.

The timing fuse shown is of the combination timing and percussion type, and if the wire *C* fails to release the percussion plunger *G* the shell is exploded by means of a percussion fuse which comes into use when the shell strikes. The percussive mechanism consists of a primer *K* held in an inverted position in the centre of the fuse body by a cup located beneath the percussive primer. The percussion plunger *L* works in a recess in the base of the fuse body and is kept at the bottom of the recess away from contact with the primer by a light spring in the plunger *M*. The firing pin *N* is mounted on a fulcrumed pin, and is normally kept in the vertical position by means of two side spring plungers. When the shell strikes, the impact causes the plunger to snap up against the primer after compressing the spring in the pin *M*. This causes the firing of the primer *K* and the explosive charge passes out through a hole in the percussion plunger chamber, not shown, to the magazine *J* and from there down to the powder in the base of the shell.

With the exception of a few minor details, the timing fuses used in the American, Russian, German, Japanese, etc., shrapnel shells are the same. The French timing fuse, however, operates on an entirely different principle.

The timing ring used on the American fuse is illustrated. Here it will be seen that the ring is provided with 21 graduations corresponding to 21 seconds in the duration of flight of the projectile. It will also be noticed that the spacing of the graduations differs. For instance, *S* to *o*, or safety to *o*, occupies 26 degrees. This, as previously mentioned, is required so that the ungrooved surfaces of the timing rings can be swung around far enough to bring them in line with the vents for firing. From 0 to 1 is greater than from 1 to 2. The reason for this is also in the relation of the vents. From 3 to 4 will be seen another variation. This takes into consideration the positions of the lower timing train and the trajectory of the flying missile. From 6 seconds around to 18 is practically a constant drop, taking into consideration the decrease of velocity, and from 18 on, the graduations begin to increase for two reasons: the decrease in the velocity of the missile and the action of gravity.



AMERICAN TIMING RING

In manufacturing shrapnel shells, a test shell is taken from every 120 and is actually fired out of a quick-firing gun into a bank of sand. If the contour of the shell in the neighborhood of the powder pocket is expanded during this test, the shell is discarded because of the liability of tearing out the rifling grooves in the gun.

## INTERNATIONAL ENGINEERING CONGRESS

Those of our readers who anticipate visiting the Panama Exposition, will do well to try and arrange to be in San Francisco from September 20-25 for the International Engineering Congress. Never has there been such a representative assemblage of engineers.

The materials of engineering construction will receive special attention and the field will be treated under eighteen or more topics, covering: timber resources; preservative methods; brick and clay products in general; life of concrete structures; world's supply of iron; life of iron and steel structures; status of copper and world's supply; testing of metals, etc.

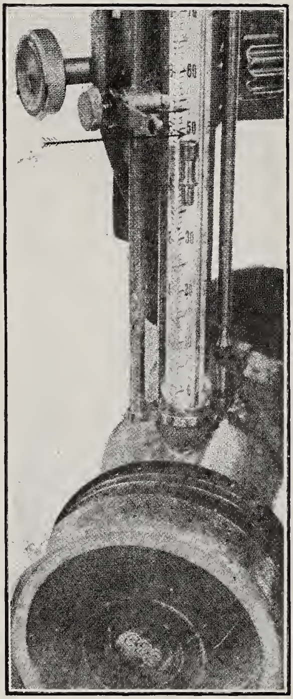
These papers will be contributed by engineers eminent throughout the world, and will be published as volume 5 of the transactions. This volume will form a most valuable acquisition to the library of all engineers and others who may be interested in these phases of engineering.

For further information and a copy of the booklet which outlines the programme and prices of the transactions, apply to

W. A. Cattell, Sec.,
417 Foxcroft Building, San Francisco, Cal.

# THE SCLEROSCOPE

R. J. Marshall, B.A.Sc.



The supplying of munitions to England has introduced a great many new problems to the Canadian manufacturer. This business like any other special line of machine work has a whole host of difficulties which have to be overcome before the finished shells can be supplied with a certainty which means successful production.

Almost the first of these difficulties to be met and overcome in the production of shrapnel shells is the mastering of the heat treatment. The steel forgings have a tensile strength varying from 75,000 lbs. to 90,000 lbs. per sq. inch before the heat treatment. This stress is raised from 125,000 to 200,000 lbs per sq. inch by heating the shell to a temperature of about 1,500° F. and quenching it suddenly in oil at 100 °F. This operation would be simple if the treatment could be exactly specified and if the material had a uniform chemical composition, but unfortunately the steel cannot be produced uniformly enough to allow the treatment to be given in precise and definite terms. Therefore the manufacturer has had to gain his own experience by experimenting and sometimes by making mistakes. A treatment which would prove successful with .45 carbon would probably cause a steel of .55 carbon to fail in passing the physical specification. The manganese, sulphur, phosphorus, silicon and nickel are the other chemical constituents which must also be considered in selecting the treatment. Each variation in the chemical composition necessitates slight changes in the heat treatment.

It is unfortunate that during these critical times our Canadian manufacturers are compelled to learn the arts of munition making. Some English Parliamentarians have surely forgotten that experience in these arts is essential before production can be forced. This seems to be a reasonable explanation of why our manufacturers were not able at first to produce the quantity of shells desired.

To heat treat a shell is one kind of a problem, but to know what effect the heat treatment has had on the steel is another problem of an entirely different kind. The elastic and tensile properties are the standard of comparision, but of course it is impossible to cut selections from all shells for tensile tests, therefore the manufacturer had to find some method of following the changes made by heat treating without damaging the surface of his shell. The instrument which has proved the most successful in this regard is the scleroscope.

The scleroscope consists of a small hammer with rounded diamond of known radius in the striking end, which is raised pneumatically in a glass tube to a height of about 11 inches. This is dropped on the surface to be tested and rebounds, the operator noting the amount of rebound on the scale attached to the glass tube; the reading on the scale is called the scleroscopic reading. The principle made use of in the calibration of this instrument is the physical relationship between the tensile and hardness properties of steel. A steel which has high tensile properties will offer a harder surface to the impact of the hammer than one which is low in tensile strength and the harder of the two surfaces will give the greater reading.

Some of the scleroscopes have a scale of tensile strengths opposite the scleroscope scale, but the tensile scale is not at all to be depended upon for reasons that will be outlined later in this article. It becomes necessary then for the operator to calibrate the scleroscope scale relating his readings to tensile tests. Pieces which have been carefully scleroscoped and which range in reading from say 35 to 55, are made into tensile test pieces and tested in tension. By comparing tensile strength with the War Office specification the safe range is found and that is compared with the corresponding scleroscope readings.

The scleroscope reading of 45 for instance, is not by any means an infallible indication of a definite tensile strength. If for example, the hammer is dropped on the same spot a number of times successsively, higher readings will be obtained. The first drop of the hammer makes a small mark, and succeeding readings enlarge the area. The amount of rebound is a function of the area of the indentation made; as the area increases the rebound will also increase.

The smoothness of the surface on which the hammer is dropped has also a bearing on the height to which the hammer will rebound. A rough surface will not give as great a reading as one perfectly smooth. Also the rebound depends upon how the piece being tested is placed under the scleroscope. If it is loosely placed on a light anvil, the reading will not be as great as if placed in a solid holder. The chemical composition of the steel also effects the reading obtained. For one set of chemical figures a reading of 45 on the scleroscope would represent a stress of say 130,000 lbs. per sq. inch, but for a different chemical composition the scleroscope reading of 45 might represent only a stress of 110,000 lbs. per sq. inch.

These fallacies in the scleroscope are submitted as evidence supporting the contention that the instrument is an aid to a close inspeciton of the steel, but it should not be taken as an infallible method of testing the tensile properties of the shell. Properly calibrated and frequently checked, the scleroscope should be indispensable to the business of producing shell.

## UNIVERSITY OF TORONTO CLUB OF NEW YORK

On the evening of April 22nd, the University of Toronto Club, of New York, held its annual meeting, which was preceded by an informal dinner.

During the meeting attention was called to the notice recently sent out in regard to the University of Toronto Military Hospital, equipped for service at the front, and a committee appointed of which Mr. W. J. K. Vanston was elected chairman. The meeting was brought to a close with reports from E. W. Stern, '84, J. S. Galbraith, B.A.Sc., '13, and others, on the work being done by the University students and graduates in connection with the war. Mr. Stern's remarks related largely to the work of C. H. Mitchell, '92, at the front, while Mr. Galbraith spoke more particularly about military affairs at Toronto.

Among those present were: President Louis L. Brown, '95, and past presidents, Dr. T. K. Thomson, C.E., '86, T. H. Alison, B.A.Sc., C.E., '93, H. F. Ballantyne, B.A.Sc., '94, E. W. Stern, '84.

After the routine business the following officers were elected for the year 1915-16:—President, Dr. E. R. L. Gould; vice-presidents, Mr. C. V. Campbell, Mr. John Langton, Dr. R. G. Snider; secretary-treasurer, Mr. H. F. Ballantyne, '94; membership committee, Dr. J. E. Bowman, H. P. Rust, '02, and A. LeR. Chipman.

Mr. H. F. Ballantyne is following the example of Dr. T. K. Thomson, as he has been appointed secretary-treasurer for another year.

## EXAMINATION SUPPLEMENT

**Fourth Year**—A. H. MacQuarrie is now eligible for the degree of B.A.Sc.

**Third Year**—H. R. Hopkins and C. E. Gage have completed the third year examinations.

**B. B. Hogarth, B.A.Sc.,** '14, is assistant engineer on the Alberta and Saskatchewan Power Survey, Water Power Branch, Ottawa.

**H. O. Hill, B.A.Sc.,** '07, now at 315 Western Ave., Aspinwall, Pa.

**Chas. T. Hamilton, B.A.Sc.,** '07, is a member of the firm of Johnston & Hamilton, engineers and contractors and Dominion and B.C. land surveyors, 73 Exchange Building, 142 Hastings St. W., Vancouver.

**A. N. Hunter, B.A.Sc.,** '08, is connected with the Canadian Inspection Co. at Detroit. His address is care of Detroit Rounding Co., Jefferson Ave. W., Detroit.

**W. T. Hall, B.A.Sc.,** '15, has accepted a position with the Braden Copper Co., Rancagua, Chile, South America.

**L. T. Higgins, B.A.Sc.,** '15, has also gone to South America with the Braden Copper Co., Rancagua, Chile.

**C. E. Hogarth, B.A.Sc.,** '15, is reinforced concrete inspector on the Welland Ship Canal at Port Weller.

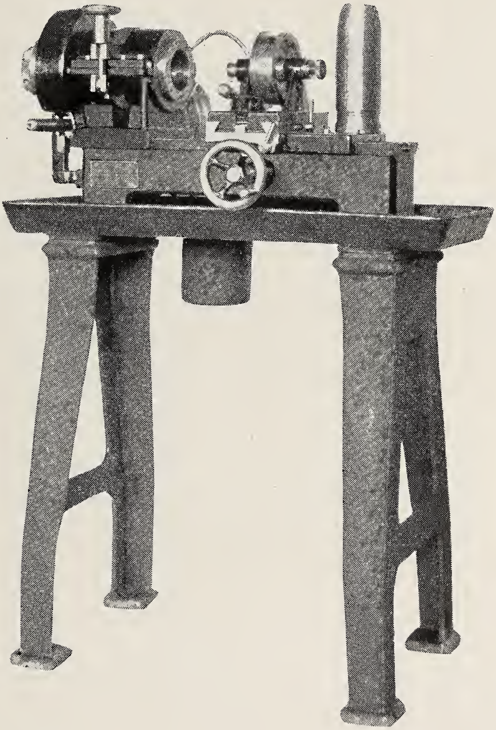
**L. G. Ireland, B.A.Sc.,** '07, has been appointed manager of the Brantford Street Railway in addition to the office which he has previously held as manager of the Hydro Electric System of Brantford.

**R. V. Jones, B.A.Sc.,** '15, is inspector for the Beaver Mine.

**R. H. Johnston, B.A.Sc.,** '10, now residing at 10162 116th St., Edmonton, Alta.

# A NEW THREAD MILLING MACHINE FOR HIGH EXPLOSIVE SHELLS

THIS machine has been developed by a Canadian manufacturer, and sold very rapidly to all leading shell manufacturers. It occupies a floor space of 2 feet by 3 feet and stands 4 feet high. The shell is placed inside the revolving spindle and automatically centred. The cutters are made of high speed tool steel and are of special design, which eliminates the change of form when sharpened, and mills the top of the thread as well as the depth. It is fitted with an oil pump and fully equipped for work. This machine eliminates all risk of having shells rejected because of stripped threads, as is so often the case when tapped by the old method.



One operator can run several machines, as they are almost automatic. The output is greatly increased by having two machines, one to thread the nose and one to recess and thread the base. A perfect thread is produced in the nose in 2½ minutes, and the base recessed and threaded in the same time. These two machines will finish a shell every 2½ minutes, or 240 in a day of 10 hours.

Prices and terms for this machine will be furnished upon application to the manager of APPLIED SCIENCE, Engineering Building, Toronto University.

## UNKNOWN ADDRESSES

**Our readers will confer a favor if they will kindly advise us of the correct, or most recent known address, of any of the men listed below**

Acres, H. G., ’14.
Alexander, J. H., ’04.
Beatty, W. G., ’01.
Berry, E. W., ’10.
Bertram, G. M., ’01.
Binns, R. E., ’13.
Blair, W. J., ’02.
Boswell, W. O., ’11.
Bowman, A. M., ’86.
Brackenreid, ’11.
Brown, D. B., ’88.
Brown, H., ’11.
Brown, E. W., ’09.
Bruce, W. J., ’07.
Burnham, F. W., ’04.
Cameron, M. G., ’09.
Campbell, A. J., ’04.
Campbell, A. W., ’06.
Campbell, J. E., ’08.
Campbell, R. J., ’95.
Carey, B., ’99.
Carscallen, H. R., ’08.
Chambers, E. V., ’14.
Chantrell, E., ’05.
Charlebois, J. P. C., ’08.
Chisholm, D. C., ’10.
Christie, F., ’06.
Clendenning, A. C.
Coulter, G. P., ’07.
Darroch, J., ’08.
De Guerre, F. C., ’11.
Derham, W. P., ’09.
Dowling, F., ’05.
Elliott, J. C., ’99.
Evans, J. H., ’11.
Evans, S. D., ’07.
Flynn, C. C., ’11.
Foreman, W. E., ’99.
Forester, C., ’93.
Francis, C. C., ’08.
Galletly, J. S., ’07.
George, R. E., ’03.
Gourlay, W. A., ’03.
Heebner, M. B., ’11.
Horton, J. A., ’03.
Hull, H. S., ’95.
Johnston, G. K., ’03.
Jones, G. R., ’06.
Kean, D. J., ’09.
Keefer, A. H. E., ’09.
Keys, W. R., ’08.
Killip, W. C., ’08.
Lawson, W. L., ’92.
Lott, A. E., ’87.
McCuaig, O. B., ’04.
Macdonald, F. R., ’08.
Macdougall, A. C., ’01.
McKay, A. G., ’07.
McKay, J. T., ’02.
McKenzie, D. W., ’05.
MacLachlan, W. A., ’09.
McLean, W. N., ’05.
McLeod, G., ’09.
McMordie, H. C., ’08.
McPherson, J. A., ’06.
Macpherson, N. W., ’09.
McTaggart, A. L., ’94.
Maisonville, A. W. R., ’10.
Malone, J. E., ’08.
Martin, F., ’87.
Matheson, W. C., ’01.
Maus, C. A., ’03.
Mennie, R. S., ’02.
Milligan, G. L., ’08.
Mitchell, L. C., ’11.
Montague, F. F., ’06.
Munro, F. V., ’03.
Murray, J. D., ’07.
Niebel, E. H., ’11.
Nourse, A. E., ’07.
O’Brien, E. D., ’05.
O’Gorman, C. A., ’09.
Oliver, J. P., ’03.
Parke, J., ’04.
Paton, T. K., ’07.
Paulin, F. W., ’07.
Pearce, K. K.
Pearson, C. L., ’11.
Pope, A. S. H., ’99.
Raymond, D. L. C., ’04.
Roaf, J. R., ’00.
Robertson, D. F., ’03.
Sanders, W. K., ’06.
Sauder, P. M., ’04.
Scott, W. A., ’06.
Shipley, A. E., ’98.
Shortt, J. H.,
Smiley, R. W., ’97.
Smith, J. H., ’03.
Squire, G. E., ’11.
Stamtord, W. L., ’08.
Stuart, J. L. G., ’07.
Szammers, C. F., ’11.
Taylor, J. W. R., ’08.
→ Taylor, W. V., ’93.
Thomas, V. C., ’08.
Thomson, J. E., ’06.
Williamson, D. A., ’98.
Wilson, F. F., ’09.
Wilson, W. H., ’10.

# Editorial

**SPECIAL ISSUES —ATTENTION CLASS 1903!**

In a subsequent issue of Applied Science the management intend outlining definitely the policy of this magazine; and in the meantime propose, by a plebiscite, to deal with the advisability of continuing to publish Applied Science, and methods of making it a more effective and efficient medium among "School" men. A very worthy suggestion has come from a member of class 1903 and it is our intention to act upon it. Special editions of Applied Science will be published every three months, as special year numbers, devoted to articles contributed by members of that year. Each year will be advised through these columns, from three to six months in advance of the date of publication, of their issue, and as many as possible communicated with by letter.

The first special issue will appear in November and will be got out by class 1903; and each and every member of that year is asked and being depended upon to contribute his share. Do not think that we will have enough material without yours, and that you are too busy. Every man can write an article on some line of work, if not engineering, he can contribute some current or personal news.

In order to avoid duplication of articles by different members in the same issue a date will be set in the letter each will receive, at which date the editor will require the names of the articles to be contributed.

It is to be generally understood by all our graduates that these special numbers will appear every three months and any year may be called upon at any time. The friendly rivalry and competition thus created among the different years should result in a great deal of added interest in Applied Science and in subsequent issues becoming better.

**EMPLOYMENT BUREAU**

In each issue of Applied Science appears a full page advertisement asking graduates to send in their name and particulars of experience, but few have done so. So few, indeed, that one would think that all had work, or at least were satisfied with what they had. This, in normal times, is scarcely ever the case, much less in the present crisis. There are many without work at all and many not satisfied with what they have, and still the help of the Engineering Society is not solicited.

The employment bureau has been reorganized and can, with the co-operation of the graduates seeking employment, be made of great value. On the other hand a file having but a few applicants for employment is worse than none at all. Conditions are improving as the following will show. During June and the early part of July we could have placed a School man as mine surveyor in Ontario, as assayer in Quebec, as mechanical designer, as assistant electrical engineer on city of Toronto Rapid Transit, as mechanical engineer with Underwriting Company, a mechanical man as editor of a Canadian mechanical journal, and others, which we had to let go after going through our files and finding but few graduate applications in each section. This is a very regrettable fact, particularly this year, as many men would be glad of such positions, and it is very poor advertising for the Faculty of Applied Science and the Engineering Society.

The Editor has got in touch with the British representative, at present in Canada securing mechanics and engineers for munition work in Great Britain, and in the near future expects to place a large number of such men. Should any of our graduates desire such work or further particulars, it is advisable to make application at once to the editor.

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**SUBSCRIBERS IN ARREARS**

All subscribers to Applied Science in arrears have received two circular letters during the past two months, in which the financial position of the Society was set out as fully as was consistently possible, anticipating that all would realize our situation and pay their dues. However, the response was very meagre indeed. So meagre, in fact, that there must be some reason.

It may be that in the rush of work the bill has been set aside with all good intentions and forgotten, as it is such a small amount. On the other hand it may be that you have received the magazine so long without being asked to subscribe that you began to feel that you were entitled to it as a graduate, and that you do not feel disposed to pay for something you had not asked for. If this latter is the case and you would be kind enough to advise us to discontinue sending the magazine to you, the Editor will write off your arrears. In offering to do this the management feel sure that few of our graduates view it in that light, although it must be acknowledged that it was poor business to let the matter run as it has.

There are others who, as life members of the Engineering Society, have expected all publications of the Society, and no doubt have been somewhat at a loss to understand why they should be billed for the magazine. In explanation, it might be said that this particular section of the constitution was changed some years ago, so as not to cover a life subscription to Applied Science, and it is to be regretted that members affected by this had not been advised. In the light of this explanation there is no doubt that everyone will only be too glad to pay up.

The management are sparing no pains to get, methodically, the general opinion of all our graduates on Applied Science and thereby hope to greatly increase the efficiency of the magazine in consolidating that "School" spirit of which we are all so proud. Not one can afford to be without this paper; but all our subscribers must be paying subscribers or something radical will have to be done.

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As a result of the considerable correspondence of late in the technical and lay press on cast iron shells, we have been striving to get an explanation of why the Allies do not use cast iron shells as the Germans are doing, and thereby increase our output. To those unable to apply critical examination this method of production may seem highly desirable. However, "The Engineer" of recent date contains an editorial, the deductions of which are based on an actual and critical examination of a piece of a German cast iron shell and raises the following objections, which are very interesting and instructive.

**CAST IRON vs. STEEL SHELLS**

"There are several objections to such shells. In the first place, where shrapnel is concerned, the number of bullets is reduced because the walls of the projectile must be made much thicker. In the case of high-explosive shell, this does not apply in so great a degree, because the walls of the steel shell are then made thicker than is necessary for strength, but there is such danger of a cast iron shell developing cracks during manufacture that high explosives cannot safely be used in them. It must be remembered that no risk of a shell bursting in a gun must be run, and no one will doubt that there is more risk in cast iron than there is in forged steel.

"Another point against cast iron is connected with accuracy of fire. To ensure this, the projectile must be perfectly in balance. The walls must not only be of exactly the same thickness all round, but they must be homogeneous. At the very high speed of revolution set up by the rifling, a small difference of weight to one side of the centre line would be quite sufficient to cause irregular shooting. With forged steel there is little or no difficulty in securing this balance; with cast iron there is always some danger of local porosity, which, besides being a source of weakness, would destroy accuracy.

"Moreover, if the projectile were cast on a chill core and was not machined internally, a risk of the core not being absolutely concentric would always have to be faced. Accurate fire would then be impossible. To remove a chill core, even if it were collapsible, it would be necessary to have a large hole in the base of a high explosive shell, of which the point is always solid, which subsequently would have to be plugged. If a sand core were used it might be removed through a smaller hole, but the machining of the interior would be difficult owing to the shape of the ogival head and the smallness of the hole through which the tool must be entered. In the case of shrapnel the boring would be much easier, because a large opening is left for filling purposes, but, owing to the small number of bullets that could be carried, cast iron shrapnel cannot be considered.

"All these facts have militated against cast iron shells, and although, of course, cast iron and cast steel were used at one time, they have entirely given place to forged steel. Furthermore the methods of manufacture of steel shell have been so developed that such shell can actually be turned out more quickly than those of cast iron of equal reliability and accuracy. An 18-pounder shell for example, can be completely machined from the bar in about forty minutes. The case for the forged steel shell is, then, complete, and there is no case at all for the cast iron shell.

### A Case of Necessity

"The answer is fairly obvious, as to why Germans are using cast iron shells. In spite of the greatness of the supplies of their modern guns and projectiles, the Germans are beginning to find them not inexhaustible under the tremendous drain that is being put upon them. Hence, guns and projectiles have been drawn from stores many years old to fill up the deficit in modern supplies. The guns use a lower powder pressure, which the cast iron is able to stand, and the shells are probably filled with black powder, so that less danger is to be feared from an accidental burst. We believe this to be the real reason for the fragment of a cast iron shell being found on the battlefield.

"Whether the Allies also are using old guns and shell we cannot say, but it is not inherently improbable. Every nation concerned has been surprised by the part artillery has been called upon to play, and it is not unlikely that all of them have drawn upon resources of every kind that can be turned to account. If the Germans are indeed using cast iron, it is a favorable sign, for it shows that even they, with all their preparation, were unable to collect enough material of a modern kind to meet the requirements of the war.

However there are those who do not deny the impossibility of firing a cast iron shell accurately but believe that it might be used effectively to break down trenches, etc.

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**A GRAND PRIZE**

We take great pleasure indeed in drawing to the attention of our readers the fact that one of our advertisers has received the only medal of honor awarded for rail joint products in the Transportation Department by the Panama-Pacific International Exposition at San Francisco. We refer to the Rail Joint Company of New York.

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**SUPPLY AND DEMAND**

The Wall Street Journal of recent date contained comparative figures showing the remarkable increase in the cost of the various munitions of war. Most of the prices it quoted are the same as those at present prevailing in Canada, and as will be seen, are causing considerable concern to the military authorities. Powder has increased in cost over 25%, rifles approximately 50%; and other ammunition 30%. Unless the supply of such commodities as copper, antimony, lead, the acids, etc., which are necessary for the manufacture of these, is increased, there will be still further advances. For spot or early delivery almost any price can be obtained.

We notice the greatest rise in picric acid, which is used in enormous quantities in the manufacture of the French powder, melinite; the British explosive, lyddite, and the Japanese powder, shimose. In fact every grade of powder which has salt petre as a constituent shows a sharp advance, as do all the explosive acids, with the exception of nitric acid.

On the other hand, however, dynamite which is used extensively for war purposes, has not increased in cost, but this may be due to the fact that it is more or less an article of commerce.

## KEYS—BASSENBERGER

Conrad Roy Keys, B.A. Sc., '15, to Alvena Dorothea, daughter of Mr. and Mrs. Frank Bassenberger, of Berlin, Ont., at Toronto, April 13th, 1915. Mr. and Mrs. Keys will probably reside in Toronto.

## ROBERTSON—MacKAY

At the home of the bride's parents, Weston, Ont., on June 2nd, 1915, Arthur S. Robertson, B.A. Sc., '14, son of Mr. and Mrs. S. Robertson, Toronto, was united in marriage to Irene, daughter of Mr. and Mrs. P. J. MacKay.

## HOWARD—LOUDON

We have to announce the marriage of Mr. John T. Howard, B.A. Sc., '13, son of Mr. and Mrs. Willson Howard, of Madison avenue, with Miss Ruth Loudon, daughter of Mr. and Mrs. W. J. Loudon. Mr. and Mrs. Howard have gone to the States and after a holiday up the Georgian Bay will settle in 223 St. Clements avenue, Toronto.

## MUNTZ—WELLER

Eric Percival Muntz, B.A. Sc., '14, son of the late V. G. Muntz and of Mrs. Muntz, Toronto, to Marjorie Louise, second daughter of Mr. J. L. Weller, engineer in charge of the Welland Ship Canal, at St. Catharines. Mr. and Mrs. Muntz will reside at Port Weller.

## ON ACTIVE SERVICE

**W. P. Murray, B.A.Sc.,** '08, has joined the Canadian Overseas Railway Construction Corps.

**R. H. Hopkins, B.A.Sc.,** '06, has been appointed signalling officer of 39th Battalion at Belleville.

**C. V. Perry, B.A.Sc.,** '14, with the 2nd Canadian Contingent in the Cyclist Corps.

**Lt. J. L. Whiteside, B.A.Sc.,** '10, with 46th Battalion at Sewell, Manitoba.

**Corp. A. T. McPherson,** '16, **Pte. G. S. Stratford,** '16, **Lieut. D. G. Hagarty,** '16, **Pte. J. A. Simmers,** '18, **Pte. P. A. Laing,** '05, **O. G. Lye,** '14, with the Second University Overseas Contingent.

**Lieut. L. S. Adlard, B.A.Sc.,** '15, is at Niagara Camp on the staff looking after the water supply.

**E. R. Grange, B.A.Sc.,** '15, formerly on mechanical designing with the Curtiss Aeroplane Co., Toronto, has enlisted for active service with the Aviation Corps.

**Lieut. Col. C. H. Mitchell,** '92, has been recommended by Sir John French for distinguished conduct.

**Lieut. H. F. H. Hertzberg,** '07, of the Canadian Engineers, who was reported as wounded in the last issue, has recovered and just recently returned to the front. He has been mentioned in dispatches from the front and has been awarded the Military Cross.

**Lieut. Elliott A. Greene,** '11, of the 9th Battery, Canadian Artillery, has also been recommended by Sir John French for Distinguished Conduct.

**Charles Cotton,** '15, with the Montreal Battery, has received a commission in recognition of his fine work at Langemarck and has been recommended for the D.C.M.

## CASUALTIES

**Lieut. Fred T. Nicholl,** '10, Eleventh Battalion, has been reported wounded.

**Pte. F. W. Clark,** '12, Fourth Battalion, is wounded.

**Sgt. C. B. Ferris,** '13, of the 2nd Field Company of Canadian Engineers, wounded at Langemarck. He was the only original sergeant left after this battle.

**Lieut. Andrew J. Gray,** '13, Sixteenth Battalion, wounded.

**Lieut. Ian MacIntosh Sinclair,** '17, Thirteenth Battalion, wounded.

**Lieut. Angus N. Worthington,** '11, Thirteenth Battalion , wounded.

**Capt. J. G. Helliwell,** '10, First Battalion, wounded.

**D. D. James, B.A.Sc.,** '89, and **O. S. James, B.A.Sc.,** '91, are now residing at 6 Leuty Ave., Toronto.

**K. A. Jefferson, B.A.Sc.,** '15, is with the Canadian Inspection Co. Resides at 40 West Main St. N., Galt.

**E. W. Kay, B.A.Sc.,** '07, now resides at 517 Bannatyne Ave., Winnipeg.

**C. R. Keys, B.A.Sc.,** '15, on mechanical designing for the Curtiss Aeroplane Co., Toronto.

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**E. V. McKague, B.A.Sc.,** '15, is resident engineer on the Rapid Transit Commission, Toronto.

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**Flynn, C. C.,** '11, was in Chicago, with the Western Electric Co., Limited, when last heard of.

**Follett, R. C.,** '10, has no address upon our records except his home address, Oakville, Ont.

**Foote, F. F.,** '13, is at Merritton, Ont.

**Forbes, D. L. H.,** '02, is chief construction engineer for the Chile Exploration Co., Chuqicamata, Chile, South America.

**Ford, A. L.,** '04, is government inspector and engineer, Department of Railways and Canals, at Prince Rupert, B.C.

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**Foreman, J. M.,** '10, whose home is in Lucan, Ont., has no business address with us.

**Forman, W. E.,** '99, was in Pittsburg with the Westinghouse Electric & Mfg. Co., construction department, when last heard from.

(*Continued on page x*)

# Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO ENGINEERING SOCIETY

Old Series Vol. 27 TORONTO, AUGUST, 1915 New Series Vol. X. No. 4

## RADIATOR TRAPS AND TEST DATA

By L. M. Arkley, M.Sc.*

The primary object of a steam trap is to actuate a valve in such a way as to permit all water or condensed steam to flow quietly out of the radiator and at the same time, to allow none of the steam to escape with it. It will be seen that, to keep the radiator well cleared of water, the valve must operate very often. It is therefore subject to more or less wear. In the main, two general principles are employed, namely, the float and the thermostat. In the float type the valve is simply part of a hollow vessel and is lifted and opened by the water collecting under it. When this water runs away the valve, of course, settles to its seat.

The thermostatic valve is actuated by the contraction and expansion of metals or gases due to heat. When the thermostat is surrounded by water, it is naturally cooler than when in contact with steam with the result that the element shortens and opens the valve.

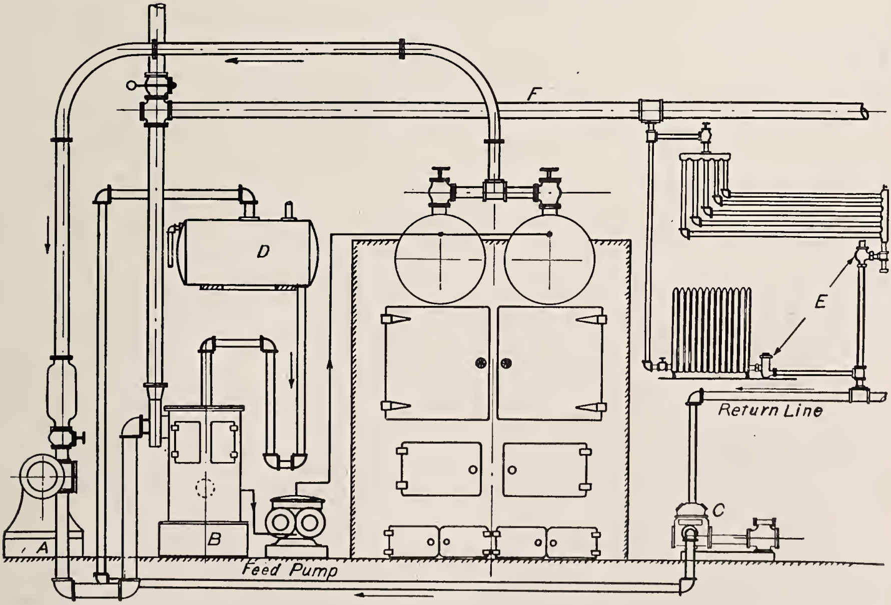

Fig. 1. Outline of Vacuum Heating Plant, Illustrating the use of Radiator Traps

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*Lecturer in Mechanical Engineering, University of Toronto.

Fig. 1 illustrates the common method of using radiator traps in connection with a vacuum heating system. Live steam from the boilers is used to drive the engine indicated at A. Exhaust steam from the engine is taken to the feed water heater B where approximately 1-7 of the heat units in it may be used to heat the feed water for the boilers from a temperature of say, 50° to 210° F., and the remaining 6-7 will thus be available for the heating system. This exhaust steam at low pressure is led directly to the radiators, and a vacuum is pumped on the return lines of the system by the vacuum pump C. The pump discharges the condensed steam into the tank D, from which it flows by gravity to the feed water heater B. After being heated to the temperature of 210° or 212° F. in the heater, it completes the circuit by being returned to the boilers by the feed pump.

In a heating system of this kind we might operate the plant with a steam pressure of from 0 to 5 pounds per sq. inch on the pipe F, and with a vacuum of from 8 to 10 inches on the return line, these values of course depending on the number of square feet of heating surface being supplied and the distance the steam has to be carried.

It is clear that under these conditions steam would blow through the radiator without being condensed and giving up its latent heat, unless some provision was made to prevent it. To stop this waste of steam, traps are placed on the return ends of the radiators as shown at E

In order to test the comparative efficiencies of several well-known makes of radiator traps the apparatus shown in Fig. 2 was fitted up in the Thermodynamic Laboratory of the University of Toronto.

## DESCRIPTION OF APPARATUS

The apparatus consists essentially of a standard type of radiator having 60 square feet of radiating surface and which is connected to the steam pipes in the same way as when set up for actual service. A mercury manometer is attached to the inlet pipe to register the pressure of the steam entering the radiator, while a thermometer in the same pipe can be used to indicate the temperature when desired. To the outlet pipe is attached a radiator trap E, a tank B, in which is collected the condensed steam from the radiator, a glass condensing coil, and a glass jar A, which condenses and collects any steam that may pass the trap.

There is an advantage in having the condensing coil and jar A of glass, as, during the test, the rate at which the steam is passing the trap may be noted and the completeness of condensation verified. The desired vacuum was indicated on gauge C, and was obtained by connecting the apparatus to a vacuum pump as shown.

## OBJECT OF TEST

(a)—To determine whether the traps performed their main function, namely, that of allowing all water of condensation to pass from the radiator without letting steam pass as well.

(b)—To determine the temperature efficiency of radiator.

(c)—To determine whether all air was removed from the radiator by the trap.

(d)—To determine whether the traps performed their functions without noise.

### METHOD OF MAKING TESTS

Before starting the tests, steam was turned on the radiation and the system allowed to heat up to its normal working condition; after this, readings of temperatures and pressures were taken at intervals of ten minutes for a period of two hours. If any water had collected in the radiator during the test it was drawn off and weighed.

By referring to Fig. 2, it will be seen that tanks A and B are so connected that they are always under the same vacuum of pressure, the water-leg preventing steam from passing to the tank B, therefore, if any steam passes the trap, it will find its way to the condensing coil and from there to the tank A. The weight of water in B represents the steam condensed in the radiator, while the water in A, after the proper correction has been made, represents the steam that has passed the trap.

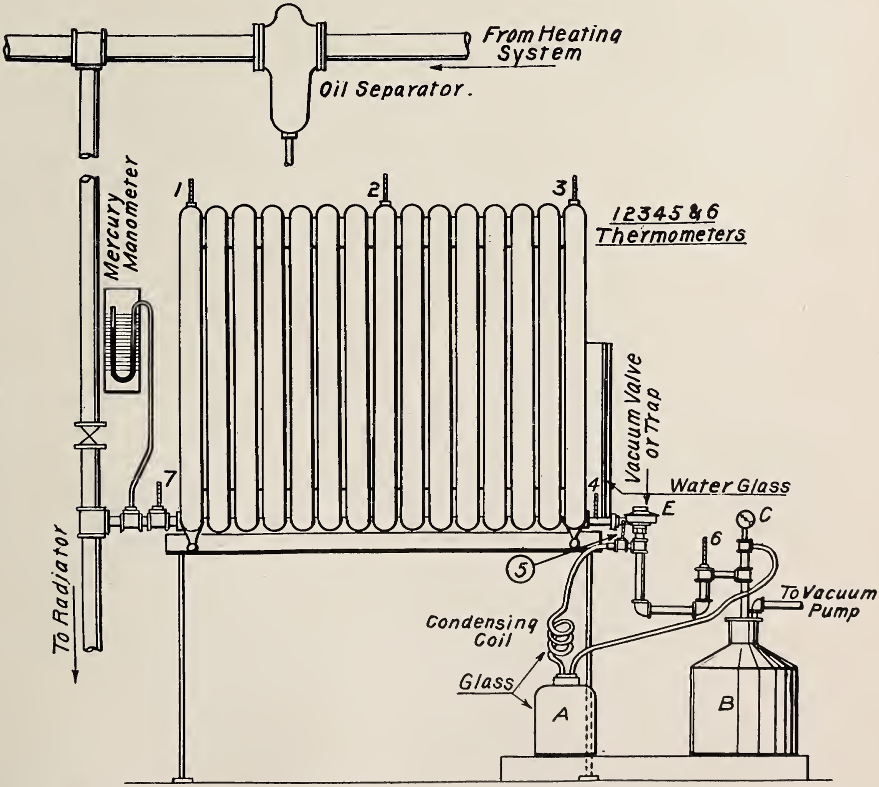

Fig. 2. Arrangement of apparatus as set-up for Testing Radiator Traps

### Method of Computing Results

In order to get the true value of the steam passing the trap a correction must be made to the quantity caught in tank A, because a certain amount of the water in the radiator which would remain as water while under the pressure in radiator would burst into steam after passing to the lower pressure beyond the trap. The following method will give a close approximation to what this correction should be.

Let A = the number of pounds of water caught in tank A.
Let B = the number of pounds of water caught in tank B.
Let r = the heat of vaporization of one pound of saturated steam under vacuum.
Let X = temperature of water at thermometer No. 4.
Let Y = temperature of steam corresponding to vacuum.
Let C = correction, i.e., the number of pounds of water to be deducted from A.
Let E = net weight of steam passing trap.

$$\text{Then } C = \frac{(X - Y)}{r} \times B \text{ and } E = A - C.$$

The above correction, while not exact, is quite close enough for practical purposes, and as it has been applied to each valve tested, the comparison should be fair.

The temperature efficiency of the radiator is defined as the average temperature of the radiator divided by the temperature of saturated steam corresponding to the pressure in the radiator. The temperature efficiency gives a very good indication of the quantity

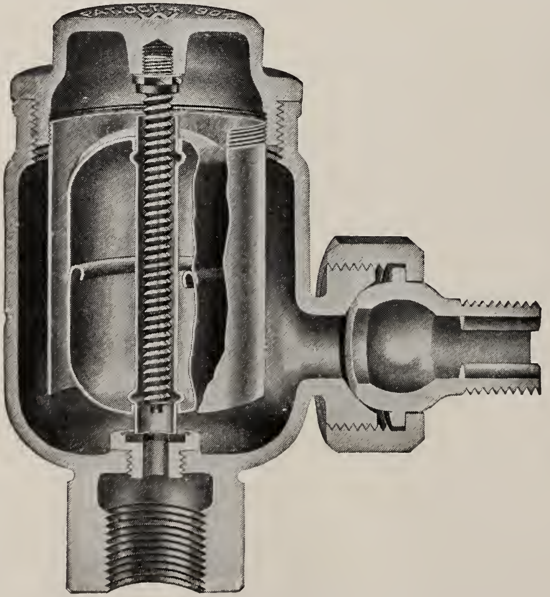

Fig. 3. Webster Water Seal Motor Trap—Float Type

of air being trapped and held in the radiator sections. For instance, if the temperatures as read from thermometers 1, 2 and 3, Fig. 2, are nearly equal, and not far below that corresponding to the steam pressure, it shows that steam is filling each section and therefore air must be absent. In the following tabulation the first test is given complete; in the others, only the minimum, maximum and average values are given for the pressures and temperatures, and the final results. Particulars of the traps tested are as follows:

### WEBSTER WATER SEAL MOTOR

This trap, Fig. 3, operates on the float principle. As shown in the figure, it consists of a metal shell in which a float fits loosely. The float is made of pressed steel with a hollow tube passing through its centre, a spiral screw fastened to the valve cover serving as a guide for the float. The air discharge is down through the hollow tube in the float which connects directly with the return line. When the water (which will rise higher in the valve than in the radiator due to the vacuum) reaches a certain height, the float rises and allows the water to be discharged.

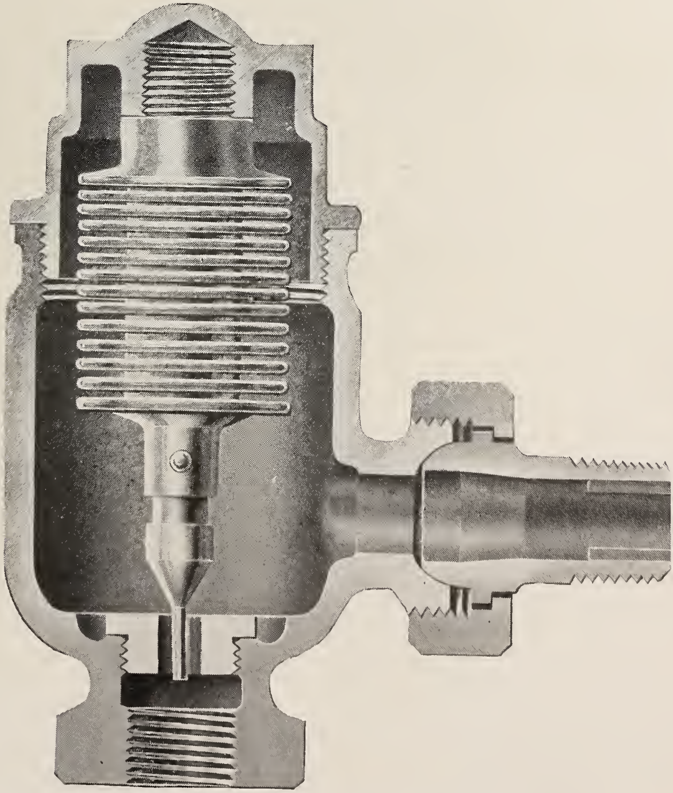

Fig. 4. Webster Sylphon Trap—Thermostatic Type

## Webster Sylphon Trap

This trap, shown in Fig. 4, operates on the thermostatic principle. Most traps which depend for their action on this principle, have an expanding member, one end of which is fixed firmly to the cover of the valve chamber, while the other end carries the valve. This expanding member is usually hollow and contains a volatile fluid which readily changes to the form of gas when its temperature is slightly increased. Suppose the valve in the trap closed. Water will begin to accumulate and its temperature will fall slightly. This drop in temperature causes the expanding member to contract which opens the valve to discharge water. As the water flows out, it becomes warmer and this allows the valve to close slightly and reduces the flow.

As shown by the results of these tests, a radiator trap made on this principle may be adjusted to work very satisfactorily. By referring to Fig. 4, it will be seen that the expanding member in the Webster Sylphon Trap is a hollow brass spiral coil one end of which is attached to the cover and the other to the valve stem. The body of the valve is of cast iron and the valve and stem of brass. The valve itself is cone shaped.

## D. G. C. Trap

This trap, a section of which is shown in Fig. 5, operates on a different principle from any thus far described. The steam passing through the screen at the right of the figure, reaches the rectangular chamber adjacent. A small, circular opening connects this chamber with the valve chamber directly below, and, through this opening, all water and air must pass.

The valve consists of a small circular disc of brass with a stem

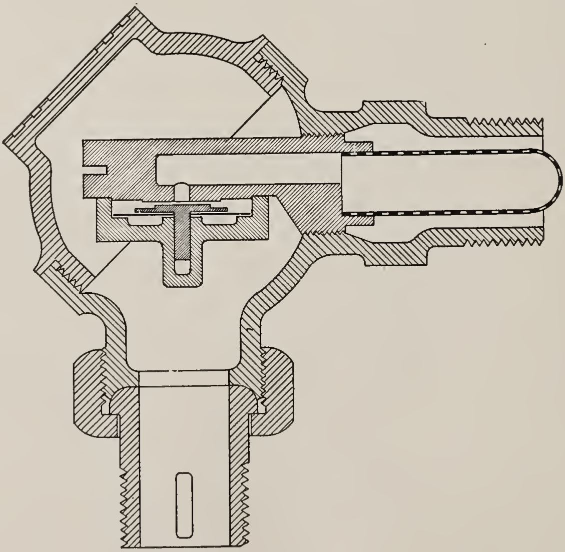

Fig. 5. D.G.C. Trap—Difference in Pressure Type

attached to the under side to act as a guide. If steam passes through this small orifice, its velocity is increased, and this high velocity steam blowing down on top of the valve disc, creates an area of low pressure above it. The disc rises and closes the opening as soon as the pressure under it becomes greater than that above it.

### Hains or "Vento" Trap

A cross section of this trap is shown in Fig. 6. The operating member which closes or opens the valve is a U tube which is hollow, and is filled with a volatile fluid. When the pressure in the tube increases, due to the increase in temperature, the prongs of the tube spread and close the valve. When the temperature falls, the prongs come together and thus open the valve. The body of the trap is of cast iron, while the U tube and valve are of brass.

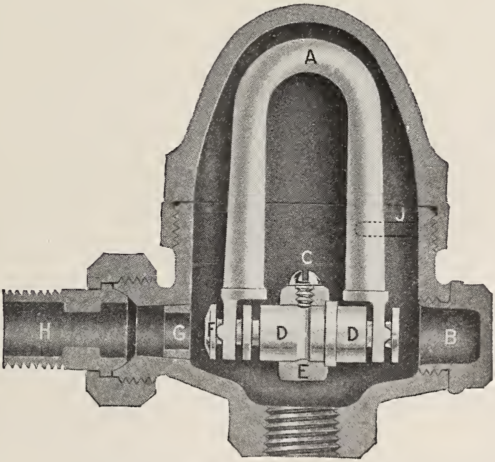

Fig. 6. Hains or "Vento" Trap—Thermostatic Type

### "Welo" Radiator Trap

This trap is shown in cross section in Fig. 7. It also operates on the thermostatic principle. The receptacle for the expansive fluid is a corrugated copper tube and, to this tube or cartridge is attached the valve. If steam comes in contact with the corrugated tube, it expands until the valve is closed. When sufficient water has collected to reduce the temperature slightly, the valve opens to discharge the water and air. The corrugated tube is of copper and the rest of the trap is made of seamless bronze.

### No. 8 Sarco Steam Trap

By referring to Fig. 8, it will be seen that this trap is in form very much like the "Welo," which has just been described and that it also works on the thermostatic principle. The main difference is that, in this trap, the expansive fluid surrounds the corrugated tube to which the valve is attached and is not within the tube as in the case of the "Welo." The body of the "Sarco" trap is of steel and the expansion member is made of copper.

### "Marsh" Reflux Trap

As seen from Fig. 9, this trap operates on the thermostatic principle, the hollow corrugated disc containing the expansive fluid is inserted between the valve and a hollow stem fixed to the top of the cover. The action is the same as in other types of thermostatic valve described.

### "Durham" No. 1 Radiator Trap

From Fig. 10 the method of operation of this trap is clear. The expansion member is a hollow corrugated disc which contains the

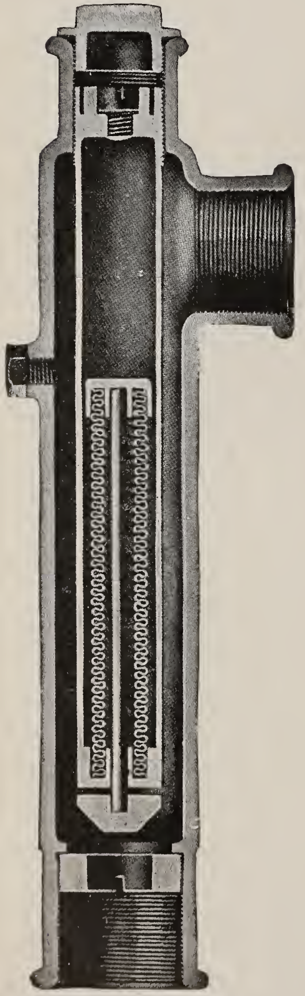

Fig. 8. Sarco Steam Trap—Thermostatic Type

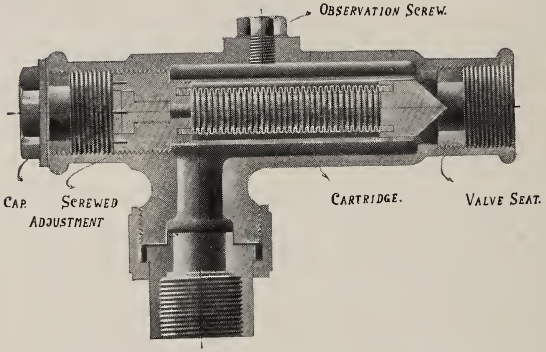

Fig. 7. The "Welo" Radiator Trap —Thermostatic Type

volatile fluid. One side of this disc is fastened to the cover, while the other side carries the valve. A slight variation of temperature inside the trap will cause the valve to open or close. The hollow disc is made of copper and the body of the trap of brass.

## Purpose of Tests

These tests were made primarily for the purpose of satisfying the writer as to the value of radiator traps, which he has had occasion to specify at different times in connection with the design of low pressure heating systems. Numerous inquiries along this line from architects and heating engineers would indicate that the question is a live one with all men directly interested, and seems to justify the publication of the results of this somewhat exhaustive test.

It must be remembered that there are other important features connected with radiator traps which cannot be decided by laboratory tests, for example, mechanical construction on which depends the life of the valve and its seat. The lift of the valve from its seat and the shape of both valve and seat determine its likelihood to clog on account of scale or dirt coming from the radiator. The ease with which the traps may be cleaned and kept in running order is also a very important feature. Mechanical knowledge and good judgment on the part of the purchaser should enable him to choose the best trap from a mechanical standpoint, but the length of life and other such questions can only be determined by comparing the action of traps operating over long periods of time under similar conditions.

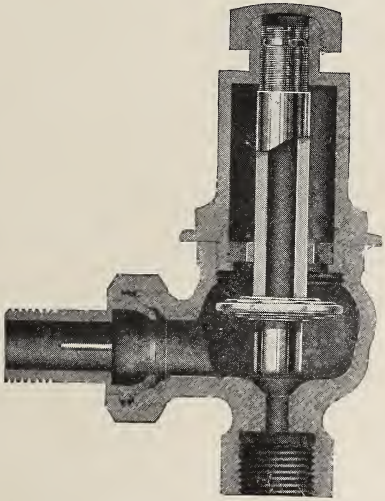

Fig. 9. Marsh Reflex Trap—
Thermostatic Type

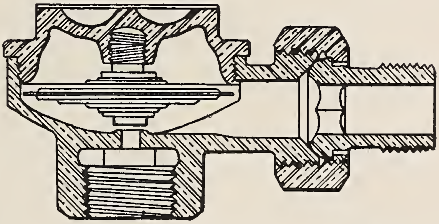

Fig. 10. Dunham No. 1 Radiator Trap—
Thermostatic Type

The writer wishes to acknowledge suggestions and help given by Professor R. W. Angus, of the Department of Mechanical Engineering of the University of Toronto, and also the hearty co-operation of the manufacturers who furnished the traps tested.

| No. of test | Values given | Time | Pressure | | Temperatures | | | | | | | Name and type of trap | Aver. temp. of radiator | Temp. efficiency of radiator | Steam condensed in radiator | Lbs. of steam passed by trap | % of steam passed by trap |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Inches Mercury | Inches Vacuum | 1 | 2 | 3 | 4 | 5 | 6 | Room | | | | | | |
| 2 | Min. | 10.11 | 2.7 | 9.0 | 214.0 | 215.0 | 213.0 | 212.0 | 182.0 | 180.0 | **100.0** | *Webster | ------- | ------- | ------- | ------- | ------- |
| | Max. | to | 3.8 | 9.0 | 216.0 | 217.0 | 215.5 | 215.0 | 191.0 | 187.0 | **106.0** | Sylphon | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 12.11 | 3.05 | 9.0 | 215.0 | 215.6 | 214.4 | 213.8 | 188.5 | 185.0 | **102.0** | Trap | **215.0** | 99.1 | 38.5 | 0.00 | ------- |
| 4 | Min. | 10.40 | 2.70 | 9.0 | 214.0 | 215.0 | 214.5 | 215.0 | 183.0 | 190.0 | ------- | *D. G. C. | ------- | ------- | ------- | ------- | ------- |
| | Max. | to | 3.10 | 10.5 | 215.0 | 216.0 | 215.0 | 216.0 | 194.0 | 198.0 | ------- | Disc | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 12.40 | 2.92 | 9.6 | 214.6 | 215.5 | 215.0 | 215.7 | 190.6 | 194.0 | ------- | Trap | **215.0** | 99.2 | 43.5 | 0.54 | 1.22 |
| 5 | Min. | 20.8 | 2.70 | 10.0 | 213.5 | 214.5 | 214.0 | 214.5 | 189.0 | 192.0 | **98.0** | *"Vento" | ------- | ------- | ------- | ------- | ------- |
| | Max. | to | 3.30 | 10.0 | 215.0 | 215.0 | 215.0 | 215.0 | 190.0 | 193.0 | **110.0** | Ther'static | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 40.8 | 2.96 | 10.0 | 214.0 | 215.0 | 214.2 | 215.2 | 189.7 | 192.4 | **107.0** | Trap | **214.4** | 98.94 | 46.5 | 0.58 | 1.21 |
| 6 | Min. | 15.5 | 2.10 | 9.0 | 213.0 | 214.0 | 213.0 | 212.0 | 186.0 | 182.0 | **106.0** | *"Welo" | ------- | ------- | ------- | ------- | ------- |
| | Max. | to | 4.20 | 10.0 | 217.0 | 217.5 | 217.0 | 215.0 | 189.0 | 183.0 | **107.0** | Low press. | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 3.55 | 3.03 | 9.16 | 214.7 | 215.4 | 214.6 | 212.5 | 188.5 | 182.0 | **106.7** | Trap | **214.9** | 99.1 | 36.0 | 0.00 | ------- |
| 7 | Min. | 10.29 | 4.50 | 8.00 | 217.0 | 218.0 | 216.0 | 207.0 | 172.0 | 173.0 | **95.0** | "Sacro" | ------- | ------- | ------- | ------- | ------- |
| | Max. | to | 4.60 | 10.00 | 217.5 | 218.25 | 217.0 | 217.25 | 194.0 | 197.0 | **101.0** | *---------- | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 12.29 | 4.54 | 9.32 | 217.3 | 218.10 | 216.9 | 214.5 | 181.0 | 180.2 | **99.0** | ---------- | **217.4** | 99.2 | 41.0 | 0.25 | 0.6 |
| 8 | Min. | 2.25 | 3.1 | 7.5 | 215.0 | 215.0 | 214.5 | 215.0 | 191.0 | 183.0 | **97.0** | Marsh | ------- | ------- | ------- | ------- | ------- |
| | Max. | to | 5.6 | 9.5 | 219.0 | 220.0 | 219.0 | 219.0 | 192.0 | 188.0 | **104.0** | *Reflex | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 4.25 | 5.08 | 9.1 | 218.1 | 219.1 | 218.2 | 217.5 | 191.8 | 186.0 | **101.4** | ---------- | **218.5** | 99.3 | 39.5 | 0.03 | ------- |
| 9 | Min. | 10.12 | 3.9 | 9.0 | 217.5 | 217.0 | 215.6 | 216.0 | 180.0 | 176.0 | **75.0** | *Dunham | ------- | ------- | ------- | ------- | ------- |
| | Max. | 10.12 | 4.0 | 10.5 | 217.5 | 217.0 | 216.0 | 216.0 | 184.0 | 190.0 | **79.0** | No. 1 Radiator | ------- | ------- | ------- | ------- | ------- |
| | Aver. | 10.12 | 4.0 | 10.0 | 217.5 | 217.0 | 215.8 | 216.0 | 182.0 | 187.5 | **76.0** | Trap | **216.8** | 99.2 | 39.1 | 0.00 | ------- |

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*All the traps tested operated without noise, and none of them allowed air or water to gather in the radiator.

### Log Sheet of Complete Data Taken in Leading Test No. 1

| Time p.m. | Steam pressure Inches of mercury | Vacuum inches | Temperatures in Degrees F. 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| 2.48 | | | | | | | | |
| 2.50 | 2.2 | 10.0 | 214.0 | 214.5 | 214.0 | 214.0 | 187.0 | 190.0 |
| 3.00 | 2.2 | 10.0 | 214.0 | 214.5 | 214.0 | 214.0 | 189.0 | 192.0 |
| 3.10 | 2.2 | 10.0 | 214.0 | 214.5 | 214.0 | 214.5 | 190.0 | 192.0 |
| 3.20 | 2.1 | 10.0 | 213.5 | 214.5 | 214.0 | 215.0 | 191.0 | 193.0 |
| 3.30 | 2.1 | 9.5 | 213.5 | 214.5 | 214.0 | 214.5 | 190.0 | 192.0 |
| 3.40 | 2.1 | 10.0 | 213.5 | 214.5 | 214.0 | 214.5 | 191.0 | 193.0 |
| 3.55 | 2.1 | 10.0 | 213.5 | 214.5 | 214.0 | 214.0 | 189.0 | 191.0 |
| 4.05 | 2.1 | 10.0 | 214.0 | 214.5 | 214.0 | 214.5 | 190.0 | 191.5 |
| 4.15 | 2.4 | 10.0 | 214.5 | 215.0 | 214.0 | 215.0 | 190.0 | 192.0 |
| 4.25 | 2.5 | 10.0 | 214.0 | 215.0 | 214.5 | 215.0 | 190.0 | 193.0 |
| 4.35 | 2.5 | 10.0 | 214.0 | 215.0 | 214.5 | 215.0 | 190.5 | 193.0 |
| 4.45 | 2.5 | 9.5 | 214.0 | 215.0 | 214.5 | 215.0 | 191.0 | 193.0 |
| 4.48 | 2.5 | 10.0 | 214.0 | 215.0 | 214.5 | 215.0 | 191.0 | 193.0 |
| Average values | 2.27 | 9.9 | 213.9 | 214.6 | 214.1 | 214.6 | 190.0 | 192.0 |

Total period of test = 2 hours.
Average temperature of radiator.................................................. =214.2
Temperature corresponding to pressure in radiator.............................. =215.6
Temperature efficiency of radiator.................................................. = 99.3
Name of Trap.................Webster Water seal motor.
Steam condensed in radiator........................................ = 38.5 lbs.
Steam passed by trap.................................................. = 0.61 lbs. = 1.58%
No air or water collected in radiator.
Operation of trap noiseless.

Editor :—It might be well to point out, that in comparing the various foregoing traps on the basis of the results of this experiment shown on page 92, their efficiency and the amount of water condensed is a function of the room and radiator temperatures. Therefore to get an accurate conception of each trap, the result as set out in the four columns to the right, should be modified by consulting the corresponding room and radiator temperature.

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**J. T. Mogan, B.A.Sc.,** '15, is on the Toronto Harbor Commission work.

**J. M. Muir, B.A.Sc.,** '15, is with the department of education, Toronto.

**Prof. C. R. Young,** '03, and **H. H. Madill,** '11, have taken their captaincy papers at Niagara.

**Wm. A. O'Flynn, B.A.Sc.,** '11, has accepted a position as 2nd chemist for the Mond Nickel Co., Coniston, Ont.

**H. M. Peck, B.A.Sc.,** '15, is on geological survey work along east coast of James Bay.

**H. A. Ricker, B.A.Sc.,** '08. Residence, 93 Sanford Ave. S., Hamilton.

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**A. A. Richardson, B.A.Sc.,** '15, is with the city engineer of Peterboro.

**A. C. Ross, B.A.Sc.,** '15, is with the Canadian Inspection Co., Toronto.

**M. L. Smith, B.A.Sc.,** '11, formerly associate editor for MacLean Publishing Co., Toronto, has accepted the position in charge of engineering at the New Technical School, Toronto.

## MINOR DETAILS IN THE ENGINEER'S CAREER

By J. H. Kennedy, C.E., O.L.S., '82

In selecting this subject for a few remarks the author has endeavored to recall the time when he left the halls of the old School, and consider what he now believes after years of experience would have been most useful to him at that time; and it has occurred to him that a few rambling remarks along the line of posting the students and young graduates upon the snags they are liable to encounter, would be a fitting subject for one, who, if not the first graduate of the old School, believes himself to be the first to reach the chloroforming age in active work. The details proposed to be discussed are not called minor because they are of little importance, but because they are unseen when leaving school and their presence unknown until they become snags to progress. The young graduate looking through his mental telescope sees himself about to cut a wide swath with a clear blue sky line, through the world up the hill of fame, and it may be fortune, with the expectation of reaching heights and depths as yet unexplored. This is perfectly right and proper, and no fault is to be found with it. May it ever be so. Engineers must be men, of broad vision and optimistic, if they are to succeed. However, the time will come to each when he will reverse his mental telescope and view as a back sight what he had so fondly looked forward to as a foresight. The present paper is an attempt to point out a few of the minor obstructions to view while they are still foresights so they may not obstruct the backsight along the narrow and crooked traverse line that so many of us follow. If successful it will be of more real value to those for whom it is written than anything that can be said along the line of description of actual construction as followed by the usual methods, so well known to the profession. Now the first jolt the young graduate receives is when he realizes that the world instead of anxiously waiting for him to emerge from the college with the latest ideas and abstruse mathematical formulae will have nothing to do with him, except as a subordinate, because he has no practical experience in actual work. So he learns for the first time that the industrial world is very slow to give him credit for knowing how to do anything until after he has done it.

He learns that no capitalist will furnish the funds for any purely theoretical man without practical experience, to experiment with; so the only possible opening for him may be a position as rodman or instrument man. This instead of being a hardship will be a great benefit to him as it will give him an opportunity not only to see work in progress, but to learn ways and means, cause and effect; also an acquaintance with the men associated with actual work, and their methods of conducting work. He should learn from his own and other mistakes as well as from their successes. While thus employed his field notes will need considerable attention. Here is where many otherwise good men fall down. It is a notorious fact that the average instrument man that applies for such work today is a nuisance to all concerned. Not only does he keep incomplete notes; but he fails to date, sign, or index his book, or record what his notes refer to, in such a way that his book will be understood by his successor. Such notes may not lead to discharge, but are most certain to prevent re-employment. For the above reason every young engineer should paste this in his hat. No railway or other company will keep a man on its engineering staff as an expert to explain his own notes; and his field notes may be his best recommend or his condemnation, whether he knows it or not.' Field notes have turned down many otherwise good men in the past and will continue to do so in the future, notwithstanding all that can be said along this line.

Those of your readers who have had the good fortune to pass their college course under the tuition of our late Dean Galbraith, will recollect that he always urged his class to form the habit of keeping a diary for reference, for details of every day occurrences, sketches, etc. The author has kept such a diary since the spring of 1882 and would heartliy recommend it to all. One cannot remember details. Memory is treacherous, besides you may be a witness at some time when your diary will be better than the other man's memory. Some years ago Smith and Jones, two college graduates, but not of the old S.P.S., and that wasn't their names, were placed upon adjoining sections of railway grade, as assistant engineers. Their work was separated by a stream over which was to be erected an important bridge. After the grading work was well along and the bridge was to be staked out and superintended, it was decided to give the work to Smith as the better man. In fact Jones was not considered a safe man to depend upon. Though Smith could quite easily have taken this work along with his present work he refused on the ground that he already had more and more difficult work than Jones and as Jones received the same salary he considered it unfair to him. The consequence was that a new man Brown was employed for the bridge work; and as Brown proved a good man, he was retained and given what remained of Smith's and Jones' work, when it became necessary to reduce the staff. Now Smith's mistake was that he did not see that Jones' unfitness was his opportunity. Though they received the same salary he was forging ahead, while Jones' slipshod work was finding him out. Through his fear that he might be called upon to do something for nothing, Smith lost his best opportunity for advancement. His superior officer was the best judge as to whether he could handle the work and the fact that it was offered to him was evidence that his worth was appreciated, as well as to the fact that he was not overworked. Young man do not fail to recognize that after you have worked for a time upon the engineering staff of any corporation, your whole stock in trade, outside the few dollars you have earned, may be bound up in the estimate your superior officer has formed of your worth, and others know or care very little about you. Now that opinion is not necessarily formed by your scholarship alone it is just as much your accuracy in details, your industry, reliability and general make up. It is his recommend that helps you to a higher position in at least nine cases out of ten; and the tenth comes to you because it is known that you have been in his employment. The fact that Jones received the same salary as Smith was no argument for Smith, as he received no less on that account. For illustration we may take another case in which Mr. Jones is an assistant engineer with a good C. P. Ry. record behind him and Smith a recent graduate of an Eastern college, is sent to him as rodman or instrument man, upon rough sidehill work. After a short time together in which they did not agree very well, Smith left his work and came to the writer with a tale of woe in which he claimed that Mr. Jones did not understand how to stake or calculate his work; and moreover Mr. Jones had left his work in his, Smith's charge, for some time and gone out on other business, so he was afraid he was doing all the work and Mr. Jones would get all the credit for it. Now where was this man to get the credit from if not from Mr. Jones himself. His eyes had not been opened to the fact that the niceties of the higher mathematics when applied to the necessarily rough work on the mountain side become absurdities. No college training in the higher mathematics will compensate for a lack of common horse sense. Leaving out of consideration the over estimate of his own importance, which Smith will soon outgrow, he was not loyal to Mr. Jones as he should have been. The soreheads of the engineering profession today are largely those who believe they have done the work of their superior officers or have furnished the brains and their abilities have not been recognized by the powers that be. This will always be the case for obvious reasons. It is not here argued that employers and Chief Engineers are always above criticism, being human like other people. Nor is it to be understood that the young graduate is in duty bound to take what he gets and be thankful that he gets anything whether it be much or little. What is claimed however, is that the salary received when making a start in the engineering world should not loom up to unduly large proportions to obscure other advantages in the way of receiving practical experience. It is experience that counts in the employer's opinion and your college training gives the power to turn that experience to your best advantage. May it aid you through the crowded ranks to a place at the top where there is said to be plenty of room.

## MERCURY

In these days of experiment, most mechanical men have more or less to do with mercury. Being an elementary substance, it might be supposed that the nature of the metal would prevent it from being adulterated. However, this is not the case.

Mercury is an expensive substance and is frequently adulterated with lead, tin and other inexpensive metals that can readily be dissolved in it without very greatly affecting its fluidity. Such manipulations spoil mercury for experimental purposes and it is well to make a simple test for detecting any foreign matter. Put a drop of the metal on a plate of glass and roll it around. Pure mercury leaves no trace and rolls in spherical globules, while the adulterated mercury forms elongated tears covered with a gray pellicle which adheres to the surface.

# NEW TYGARD ENGINES FOR IMPROVING SUBMARINE SERVICE

James W. Tygard

The Secretary of the United States Navy, Josephus Daniels, is making every effort to increase the efficiency of the submarine, and the Tygard Engine presents a new plan by which the great difficulties, due to the impure air discharged from the storage batteries, used in propelling the submarine when submerged, are removed.

## Present System

In the present system while the submarine is not submerged, Deisel engines are used to compress air for the use of the crew and for the propulsion of the torpedoes from the tubes of the submarine.

The Deisel engines also generate electricity which is stored in a heavy and bulky system of batteries; the electricity being used later when the boat is submerged to drive its propelling screw by means of an electric motor.

This present method is a heavy, cumbersome, power-wasting system, and has the very great disadvantage of having the air, which the crew is forced to breathe, contaminated with the noxious gases that are continuously discharged while the storage batteries are in operation.

## New Method

By the new system, the Tygard double-acting oil engine is used to compress air under high pressure in a system of steel bottles or reservoirs, which occupy some of the space formerly occupied by the storage batteries that are now rendered unnecessary.

The electric generator for driving the screw is totally eliminated; the compressed air being led from the bottles to the reversing type of rotary air engine.

The compressed air after performing its work of propelling the submarine, is exhausted from the engine direct into the body of the vessel, where it adds its supply of pure air necessary to sustain the life of the crew while the submarine is travelling submerged.

Hence, the longer the submarine travels submerged, the more fresh air is supplied to the crew by the vessel's engines for breathing purposes.

The rotary air engine is connected direct to the screw propeller. The oil engine is geared to propeller shaft by the Tygard variable diameter wheel drive giving variable speed and cut-out without clutch.

When air pressure becomes oppressive the oil engine is started, burning up the excess air pressure and exhausting overboard.

Air engine can be used for reversing and manouvering, and starting oil engine.

Double power may be obtained for emergencies by using compressed air in the rotary engine.

Electricity for lighting and heating can be obtained from electric generator direct connected to small auxiliary rotary air engine.

### Increased Efficiency

Reduction in engine weight rendered possible by the new type of Tygard double-acting oil engine and the substitution of the Tygard rotary engine for the electric dynamo, and its attendant batteries, will more than double the amount of mileage possible from a given weight or size of vessel, thus immensely increasing its efficiency.

This new plan will allow the submarine to accompany the fleet to any destination as part of same and permit the flotilla to operate with the same freedom of the fleet, without the limitations under the present system of a "base" of operations.

All existing submarines can easily be changed over to the new system without any extensive alterations of the boat's structure.

### Life and Death

The fact that this system permits the storage of at least one hundred times more air under compression for the use of the crew renders less possible the regrettable and fatal disasters which have so often overtaken submarine boats that fail to come to the surface when they wish.

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## PERSONALS

**W. H. Stevenson, B.A.Sc.,** '01, is secretary of the Power Plant Specialty Co., Monadnock Block, Chicago.

**C. P. Sills, B.A.Sc.,** '11, is now at Seaforth, Ont.

**E. H. Scott, B.A.Sc.,** '15, is guiding tourists throughout northern Ontario for the summer.

**R. G. Scott, B.A.Sc.,** '15, is on geological survey work around Revelstoke.

**J. B. Stitt, B.A.Sc.,** '15, is with the Braden Copper Co., Rancagua, Chile, South America.

**J. E. C. Stroud, B.A.Sc.,** '15, is assistant chemist on smelter at Anyox, B.C.

**O. T. G. Williamson, B.A.Sc.,** '09, resides at 1345 North Shore Ave., Chicago, Ill.

**F. H. Wrong,** '11, resides at 355 Bedford St., Sandwich, Ont.

**J. A. Whelihan,** '03, is ranching somewhere in the west. Try Box 165, Regina, Sask.

**H. A. Wood, B.A.Sc.,** '15, is in charge of surveys for the Eastern Division of Toronto Harbor.

**H. H. Brown, B.A.Sc., '14,** in June last met with a very serious accident at the Lackawanna Steel Co.'s plant at Lackawanna, N.Y., in which his leg was broken and his hips broken and dislocated. He will be unable to engage in his profession for about another six months.

**W. M. Brodie, B.A.Sc., '95,** is with the Sterling Coal Company, Ltd., 95 Bay St., Toronto.

**R. H. H. Blackwell, '10, B.A.Sc., '15,** is with the Canadian Inspection Co., Toronto. His address is 32 Wilton Crescent, Toronto.

**W. J. Blair, B.A.Sc., '02,** is living in Calgary with large farming interests in Alberta.

**E. W. Berry, D.L.S., '10,** is on D.L.S. work. His home is at Seaforth, Ont.

**L. R. Brown, B.A.Sc., '15,** his address is 229 Albert St., Sault Ste. Marie, Ont.

**W. H. Bonus, B.A.Sc., '15,** is with the Canadian Inspection Co., address care of Empire Mfg. Co., London.

# VALUE OF ECONOMICS AND BUSINESS TRAINING TO THE ENGINEER

By Eugene W. Stern, '84, M. Am. Soc. C.E.

It has become more and more evident that the engineer is occupying a continually stronger position in the industrial and business world of to-day. Not only as one who is responsible for the design and supervision and the execution of work of a constructive nature, but also as a manufacturer, manager or partner in important organizations.

There are but few large constructing or manufacturing concerns in this country, in which somewhere near the top there is not a highly competent, technically trained man. In New York city, for instance, practically all of the engineering contractors engaged on the more important work, such as the subways, the Catskill water supply system, or the Barge Canal work, have engineer members of the firm as partners.

A generation ago this was not the case. The engineer's field was not nearly so broad. His activities were confined to railroad or municipal work almost entirely. The manufacturer hardly knew him. Andrew Carnegie was one of the first of them to make use of his services and he has most generously and frequently testified to the invaluable services rendered to him by the engineering profession. Those of his competitors who did not follow his lead in this direction were driven out of business.

I believe I am not exaggerating when I say that those corporations who do not to-day show full appreciation of the engineer's work are in a state of decline.

This widening of the field has brought with it, of course, larger responsibility and the necessity for a somewhat different and broader kind of training than what would have been sufficient in the past.

Nowadays the consulting engineer must often advise financial corporations as to many things involving a broad knowledge of economics and finance. For instance, he may have to pass upon the desirability of the construction or purchase of railroads, mines, manufacturing and power plants. He would be very much handicapped were he not to understand a great many of the things which the business man, lawyer and man of affairs concern themselves with, as he has to deal with these men and look at things from their view point. He should, therefore, have a well rounded training, his equipment comprising not only his mathematics, his mechanics, his field and shop practice, but also the training to enable him to deal with the larger affairs in which a knowledge of economics and of course some business training is essential.

The engineer, contractor, or manager, must not only be thoroughly capable in methods of construction and the details of economically handling materials, but must also understand how to handle labor and be thoroughly familiar with business and financial principles and methods.

The things which I have outlined above as being to-day in the proper sphere of the engineer's work, require a broad foundation which must be acquired sometime in his career, if he is to meet his responsibilities.

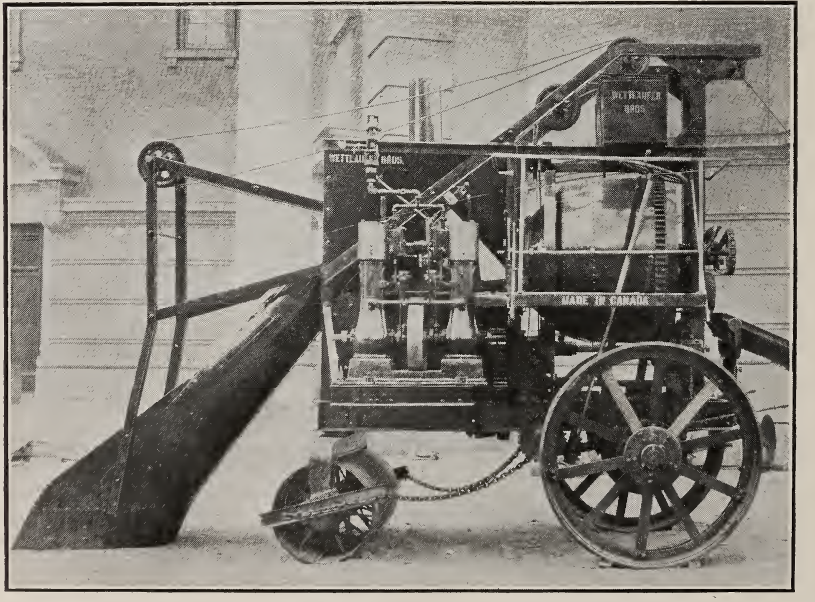
Economics, I believe, should be taught at college, as it is more or less an abstract study and its principles are readily elucidated in the lecture room.

The essential business training, however, should be acquired as an employee in the actual work, for the reason that it is much easier and quicker to obtain the right kind of business knowledge and the practical experience which goes with it, in this way.

## COMBINED MIXER AND ROAD ROLLER

Every contractor has hitherto found it necessary to own at least two big machines—a concrete mixer and a road roller—in order to build concrete roads or roads with a concrete foundation. Wettlaufer Bros., Toronto, now claim that a contractor need invest in but one machine, which will take the place, they say, of both mixer and roller.

They have just placed on the market almost ingenious and unique machine—a combined concrete mixer and steam-driven road roller. The machine weighs 24,000 pounds with roller wheels; 15,000 pounds with small wheels. The entire machine is controlled by one man from one platform, all levers being within reach. He



is not required to leave the operating platform excepting to stoke the fire occasionally.

The machine is capable of rolling at a speed of 9,284 feet per hour. The power is developed from a dry back horizontal boiler of 16-18 h.p. (at 125 pounds steam), by means of a pair of 5 x 5 twin engines, with a speed of 300 r.p.m. The machine has two speeds forward, and is reversible at each speed. The power is transmitted through cast steel gears. The power transmission is sturdily built, and this, in fact, can be said of the whole machine.

The rear roller wheels are each 60 in. diameter by 17 in. face. The front roller is 34 in. diameter by 5 ft. 9½ in. face, and is constructed as four separate wheels. Smaller wheels are also supplied with the machine to be used as desired. The over-all height of the machine is about 10 ft.; height, 12 ft. 6 in., with roller wheels; rolling width approximately 9 ft.

Forming a compact and integral part of the roller, there is mounted a heart-shaped concrete mixer, which has a capacity of 14 to 16 cu. ft. per batch, with a drum speed of 16 r.p.m. The drum is 48 in. diam. x 44 in. in length. The hopper speed is from 8 to 15 seconds. There is a boom delivery of any length desired, but the drum is built high enough to permit a gravity chute to be used to any part of the roadway. The centre of the discharge end of the drum is 6 ft. 9 in. above the ground.

The machine is not being marketed as an asphalt roller, but is primarily intended to enable the contractor to roll the subgrade at night and then to mix concrete during the day, all with the same machine. Whether or not the idea of combining a mixer with a roller proves to be practical and economical, the machine is certainly a new idea and interesting, and it will find a place in paving history.

## BUFFALO EXTENSION AND RECLAMATION

By T. Kennard Thomson, D.Sc., S.P.S., '86, M. Am. Soc. C.E.

The very name of the city is a misnomer, as there is no record of bisons ever being at this site, unless, possibly, an odd one or so in captivity.

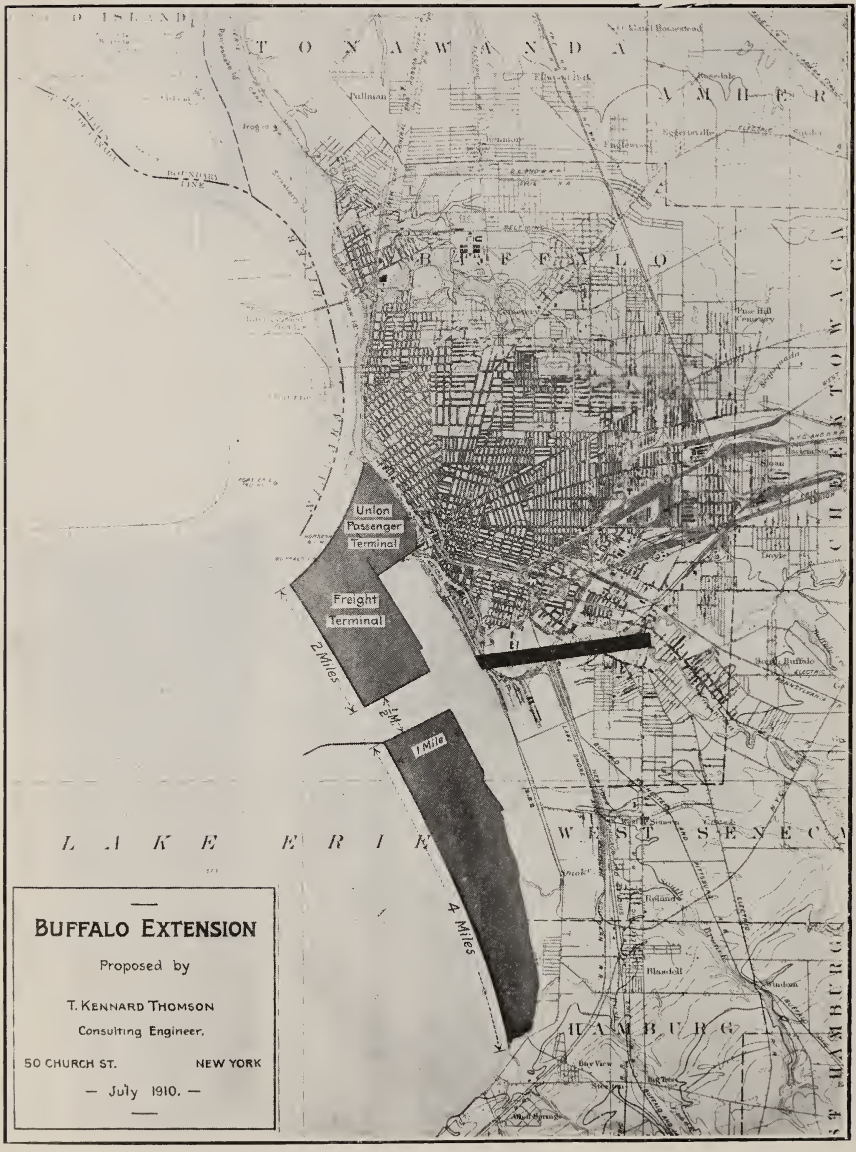
As the ultimate destiny will be a single city from Lake Erie to the Lewiston Escarpment and then, probably, on to Lake Ontario, the question of the future name of the city will have to be settled. And many wonder whether the people of Buffalo or Niagara Falls will insist upon keeping their own name.

Many prominent Buffalonians have told me that there is no justification for the name Buffalo and that, therefore, the future combined city of Buffalo, Tonawanda, La Salle, Niagara Falls and all the other intermediate towns will be, perforce, Niagara Falls.

Like all other American cities, Buffalo has made great strides, partly due to General Greene and his associates, who introduced asphalt streets so extensively into the city many years ago.

The result now is almost a solid city from Niagara Falls to Lake Erie, but under many names and governments.

It might be stated here that one of the first important highways to be built in this country was the Military Road, of about eight



miles in length, in almost a straight line from the Lewiston Escarpment to La Salle, on the Niagara River above the Falls. This diagonal short cut saved the roundabout trip by the banks of the

River and the Falls, and was built, of course, to shorten the haul of merchandise from Lake Ontario to Lake Erie—the boats being unloaded at Lewiston and the material reloaded on other boats at La Salle. Even boats were taken up in sections, put together and launched at La Salle. All kinds of furs, etc., were brought back over the same route.

After having enjoyed a period of growth and prosperity Buffalo is suffering from the lack of new enterprise, as no prosperity will continue of its own accord, and unless new ideas and new energy are put forward and pushed to completion, stagnation ensues.

Buffalonians all know that they have reached a period of serious depression, but they have not yet realized how to overcome it—and yet the remedy is perfectly obvious and ridiculously simple, when once realized, as I have pointed out to some of the members of the Chamber of Commerce and others.

Incidentally, I might remark, that in December, 1902, I submitted a plan to Mr. Rust, then city engineer of Toronto, and to others, for the improvement of the Toronto harbor—a plan which was considered at that time entirely too visionary and expensive, but which is now being carried out by the Harbor Board, and promises to make Toronto one of the leading and most up-to-date harbors on the lakes.

The plan which I have submitted to Buffalo and by which I expect to make Buffalo the greatest city on Lake Erie, consists of making a new and safe harbor on an extensive scale—which will not only pay for itself but will also supply money for other developments.

Briefly my project is:—

1st. To construct a breakwater or retaining wall from, at, or near Porter avenue, for a length of about two miles, or out to the present Government breakwater, and then continuing it for one mile beyond—a total curved length of about three miles. See plan.

2nd. To construct another retaining wall or breakwater from near the "Terrace" out to the present Government breakwater.

3rd. To construct two parallel (half a mile apart) breakwater or sea walls, from the Government breakwater, for a distance of one mile, into the lake.

4th. Cut a channel through the existing breakwater between these two parallel retaining walls.

5th. Fill in or reclaim the areas bounded by these breakwaters. See shaded portion on the plan.

These areas as shown cover about seven square miles and can be added to, to an unlimited extent, as required.

6th. Make a new Buffalo River from 500 to 1,000 feet wide, thus reclaiming and making valuable much land that is now spoiled by the winding, shallow river, railroads, etc.

7th. Build a real union passenger station, which will also have access to the lake, where the passengers from lake steamers can step directly into the trains.

8th. Construct a union freight terminal, where all the railroads can transfer merchandise to and from each other, and to and from the lake and canal boats.

The railroad tracks should pass under the city of Buffalo by means of tunnels or subways, releasing enough real estate—now owned by the railroads—to far more than pay them for the expense of the great improvement.

9th. Utilize the balance of the reclaimed land for summer resorts and cottages on the lake front, and for manufacturing concerns behind.

The walls around the union passenger station should form an enclosed space and be carried down to bed rock, which would be found to be from twelve to twenty feet from the surface of the water. The enclosed space will then be pumped out and be ready for the foundations for the buildings, tracks, etc.

By building jetties, etc., much of the remaining portion would, in time, be filled up by the sand which comes down the lake, especially during storms, when the wind is in the right direction.

As soon as this work starts there will be railroad tunnels from the Canadian side of the river to this new land.

Another advantage will be a real terminal for the Barge Canal, for transfer to the railroads or lake boats, which will be perfectly safe and of ample dimensions.

Some people fear that the addition of new land will lower the values of the old, which is absurd. In the first place, the new land will only be added as required or paid for—in fact, after obtaining the rights to go ahead, and laying the work out on paper, enough land can be sold to start the work, and to keep the work going on; so this is not a serious engineering nor even financial problem, but simply one of education.

Cleveland and other ports will soon leave Buffalo behind if Buffalo does not soon wake up.

The fine boulevards from the parks, with which Buffalo is so well equipped, should be continued so as to pass by the proposed union passenger station, and on through the new land, using tunnels under the channel.

The new city, or rather extension of the City of Buffalo (or Greater City of Niagara Falls), which will be created by this undertaking, **should have all the space—for a depth of one floor—below the street level, kept free, so that it will never be necessary to tear up the street surface to lay pipes, sewers, subways, etc.,—in short a model city should be laid out from the start.**

The lake shore on the new land should be kept for cottages on one side of the boulevard, and bathing beaches on the other side; and this can be gradually pushed out into the lake as the manufacturers require more room. In addition to manufacturing concerns of all kinds, which will be accommodated here, ample room will be provided for coaling stations, lumber yards, grain elevators, dry docks, ship building yards, automobile works, submarines, aeroplanes, etc.

With unlimited cheap electric power, good money and labor markets at hand, and this work started—can anyone imagine stagnation in Buffalo for many decades to come?

# LETTERS FROM GRADUATES

## Can a Duck Swim?

Dear Mr. Editor,—On page 51 of your June-July issue, "A Graduate" asks if there is a "School" spirit after graduation? In reply I ask another question which it seems to me is just as serious: Can a duck swim? Anyway, the answer to both questions is the same.

The measure of the strength of the "School" spirit is another matter. My experience of twenty-odd years since graduation has taught me that the "School" spirit is stronger than the tie that exists amongst graduates of many other universities. I submit, however, that it is not so strong as it ought to be.

In case "A Graduate" has not met this spirit since he left, I would say that it manifests itself by arousing interest when one School man meets another, by pleasant reminiscences of the four School years, by a desire to join with other School men on occasions, by an interest in the perusal of APPLIED SCIENCE, by a desire to know what is happening in School affairs, by the satisfaction of reading of School successes, by the pride that arises when another School man comes to the top, and by the thrill set up at the sound of the joyous Toike Oike! Toike Oike!

Should there be a "School" spirit after graduation? Undoubtedly there should.

And in reply to the last question, "Of what use is it?" One is tempted to throw up his hands and reply "What's the Use?" In my opinion the usefulness of the School spirit is beyond estimation. I have already suggested usefulness in discussing the manifestations. Let me go on. If the school spirit were properly cultivated, every graduate would subscribe for APPLIED SCIENCE and pay for it, thus making our College paper financially independent, instead of face to face with indebtedness. (School men don't appreciate APPLIED SCIENCE enough, not realizing that it is a most creditable periodical. I am proud of having a complete set from 1885 to date). If the proper School spirit existed there would be a closer bond of union between the faculty and the graduates than that which now exists. If there were true School spirit more of the School men would have better positions than they hold, even if no other principle applied than that of giving a fellow-graduate the preference, other things being equal. And I cannot help feeling that a really true School spirit would lead more of our graduates to take an interest in the great professional societies, for by so doing they would help to elevate themselves, assist in raising the standard of the profession and at the same time place the School in the high place that it deserves.

"A Graduate" who is glad to sign himself,

WALTER J. FRANCIS.

# INCREASED PRODUCTION IN CANADA

By Wm. Batten McPherson, B.A.Sc., '11

Many Canadian manufacturers have suffered greatly from the effects of the war. There has been a great dropping off in agricultural implements, steel rails and most other steel products except wire and in various materials used in building and construction. War conditions explain the increases that have accumulated and wheat and foodstuffs as much as cartridges and shells largely explain the situation. France and England are taking enormous quantities of wheat and will continue to do so.

Canada has sent little ammunition to Europe as yet but by October and November Canadian munitions will commence to play a part in deciding the issue, for according to the experts, not the soldiers in the trenches but workmen in the factories, are now carrying on the war. The Allies have a stupendous task clearing the Germans out of Belgium, France, and parts of Russia. The war will probably not be decided until this is done. Military men scout the suggestion that this is an impossible task. Modern engineering can blast its way through mountains of rock; similarly it can blast its way through human impediments in Belgium and France. And in all its hideousness, that is the aspect this twentieth century military situation presents.

No forces, even that of human beings, can withstand the shock of lyddite and melinite. It is only a question of hurling enough at the obstruction. Shrapnel shells exploding in a fan-like mass of bullets over the trenches, produce little more permanent effect than the sprinkling of toilet water; they kill men indeed but the great defences, the trenches are still there, and there are apparently new victims enough to fill the vacant places. But huge charges of high explosives, falling in or near the trenches, simply tear them to bits; concrete, earth and fragments of human beings mingle together in one horrible destruction.

If the Allies can do on an enormous scale, what the English did at Neuve Chapelle and the French at Souchez, they can literally blow the Germans across the Rhine. If the Germans can utilize the same methods against the Allies they can win the war. The issue depends upon which side can use lyddite to the greatest effect. This in turn, hangs upon which side can get the largest quantities.

The countries that send to their armies at the front the largest quantities of explosive shells will probably win this war.

Germany and Austria depend only on themselves. The Allies depend on the remainder of the world. Canada must take her place. The enemy has prepared large quantities of munitions in anticipation of this war, they have been exploding it at a prodigal rate in the past year. When they have exhausted these supplies what are their facilities for further manufacture? How extensive is their access to raw materials? By occupying Belgium, Northern France and Luxembourg, they have acquired territories rich in metal mines which will strengthen their resources. But the position of the

Allies is stronger. England and France can lay the whole world under tribute. Both countries had small reserves of munitions when the war began. But so long as they can hold their present position, they can beat time until they have organized a great and steady supply. They can draw raw materials from a dozen sources in other countries. Canada must be included. We require to work our factories as well as recruiting stations. With England, France, Russia and Italy enlisting the world's mining and manufacturing resources and Germany and Austria depending on themselves, the great military superiority of the Allies becomes apparent. Every man in the field requires at least one man in the workshop. Germany and Austria have to keep millions of their finest men in the factories—men who would otherwise go to the front. But the Allies can enlist huge armies of workmen, the world over—men who are really fighting their battles as immediately as though they were stationed in the trenches.

The newspapers describing great war orders received by American manufacturers, and the extensions which these same concerns are making to their plants give some idea of this new industry. We believed that the production of ammunition was a specialized industry; that only factories constructed for that purpose could do it. But practically any factory that has a lathe can turn out shells. A list of sub contracts let by the Canadian Car and Foundry Company in the United States illustrates this point. Manufacturers of hardware, automobiles, recording and computing machines, drop forgings, locomotives, farm implements, bicycles, screws, steel cars and a dozen other products are now turning their energies to producing shells. Canadian industries are receiving orders but more of our manufacturers can adapt their plants to obtain their share of business and to do their part. Concerns that have been making shrapnel can make explosive shells also; indeed these are less complicated and easier to make than shrapnel, and when our factories can add hundreds of these shells a week to the output of the Allies the situation on the battlefields will gradually change.

Amongst the effects of the war on Canada are the improved understanding and the friendlier feeling between the industrial east and the agricultural west. The common interest involved in increased production has brought the grain grower of the prairie provinces into a harmonious relation with the manufacturer of the east. It is freely recognized that the present world struggle is one of resources and that the supreme duty of Canadian citizens at this time lies in the utilization to the utmost of the bountiful resources with which we have been blessed.

A substantial increase in Canadian production on a sound economic basis is an essential step at the present stage of this country's development. A campaign has been launched to encourage and stimulate larger production in all parts of Canada. The importance of raising larger quantities of meat supplies has been particularly emphasized. The live stock industry has not kept pace with agriculture and manufacturing. During the past twelve years wheat production in Canada has more than trebled. Manufactures have been doubled in volume of output. Horses have increased fifty per cent., but food animals have increased in that time less than twenty per cent. Now that the prices of all kinds of grains and fodder have advanced to record heights, the problem of making a profitable business out of cattle, sheep and swine is a difficult one to solve.

Increased production from the land is the basic argument in the campaign which has arisen as the result of the war. All other increased outputs in Canada must depend upon that which comes from the soil. Of late years the volume of business in Canada has not been proportional to the size and value of the yield of produce from the soil. The future was taken into account to an exaggerated degree, and in Western Canada particularly, banking, railway construction, municipal and all manner of civil works advanced until they were ten years ahead of their time. The land is now sought as the best economic means of squaring the nation's foundations and fighting the Empire's battles. This year the grain crop of Canada promises to be exceedingly large and it is a national undertaking to see that every farm is manned with an adequate supply of labor. It would seem necessary that many of the unemployed industrial workers in the towns and cities must serve their apprenticeship as farm laborers.

It has been said that the present crisis has brought into relief several very important facts. First, the transcontinental railway systems necessary for a considerable margin of further agricultural development are practically completed. Secondly the country is provided with industrial machinery for a population considerably in excess of its present numbers. Thirdly, the development of the primary industries of the country has been relatively inadequate. Fourthly, the financial situation is well in hand and presents no insoluble difficulties. In the first two cases there has been probably both waste and over anticipation of increase of population, but at all events, the work is done, the money has been borrowed, the responsibility is shouldered, and, as a matter of fact, the country as a whole is amply able to carry the burden. In any case we find ourselves in possession of some 36,000 miles of railway in reasonably good condition, and more than adequate to deal with the large task involved in conveying to market the primary products of a country situated as Canada is, with a small seaboard and a long, relatively narrow tract of country.

In regard to the internal economic condition of Canada, it is perfectly natural that the newer parts of the country should be the main centres of anxiety. Several cities in the west have been somewhat embarrassed by extravagant assessment of city values, and too much haste to proceed with municipal improvements ahead of actual requirements.

They have lost and are losing population, and the collection of taxes on their high assessment values has been somewhat difficult, but on the whole these towns appear to be meeting the situation with courage, show no disposition to consider the question of default on their interest and in many cases are beginning the process of cutting down their assessments. Although last year prices for grain stuffs were high, it must be remembered that the crop was small. Still the principal and interest on farm mortgages were surprisingly well met. The effect of this year's large crop on the whole west must be very beneficial indeed, and it is quite inevitable that the western cities will get their share of the benefits accruing.

The trade returns of the Dominion for the last fiscal year reflect the general trade restriction both before and during the war up to March 31st last. As compared with the preceding year there was a net decrease of about 158 millions in the exports and imports of merchandise.

It is encouraging to note that for the first time in many years the balance of trade for the year in regard to imports and exports of merchandise is in Canada's favor, the total imports being $455,471,471 while exports are valued at $461,442,509. The imports of coin and bullion during the last fiscal year amounted to no less than $131,992,992 as compared with $15,236,305 for the preceding year. Canada's imports from the British Empire for the year totalled $116,272,787, a decrease of nearly $40,000,000 as compared with the preceding year. Imports from Great Britain which totalled $90,085,840 fell off by nearly $42,000,000. Imports from the British West Indies, however, increased by nearly $2,000,000. Imports of merchandise from the United States last year totalled $296,632,506, a decrease of nearly $100,000,000.

Canada's exports to British Countries during the year totalled $237,558,704, a decrease of nearly $10,000,000 nearly all of which was in exports to the United Kingdom. As compared with this Canada increased her sales of Canadian produce to the United States some $10,000,000 the total for the year being $173,320,798. During the year Canada bought from the United States $123,000,000 worth of goods more than she sold to the United States. In the case of Great Britain the Dominion sold $121,000,000 worth of goods more than she bought.

The increase in exports of merchandise during the year was due solely to the increased transportation through Canada of foreign produce, which was greater by some $28,000,000 than in the previous year and was made up principally of horses, oats and wheat bought from the United States for war purposes and shipped through Canadian ports.

The exports of Canadian produce show a decrease of $22,169,603. Exports from the mine decreased from $52,039,054 in 1914 to $51,740,989 for 1915; the fisheries from $20,623,560 to $19,687,068, agricultural products from $198,220,029 to $134,746,050.

On the other hand exports of animal produce increased from $53,349,119 to $74,390,743 and of manufactures from $57,443,452 to $85,539,501. The increase in the exports of animal produce reflects, of course, the large sales to the United States of beef cattle following the taking down by the United States of the tariff barriers.

The increase in the exports of manufactures is largely due to Canadian sales of war munitions to the Allies.

The effects of the war are seen in the figures of the trade with France and Germany. Imports from France last year totalled $8,449,186 as compared with $14,276,378. Exports to France totalled $14,595,705 as compared with $3,810,562 for the preceding fiscal year. From Germany Canada bought during the twelve months goods to the value of $4,314,805 as compared with $14,586,223 for the preceding year. To Germany Canada sold last year goods to the value of $2,162,010 as compared with $4,423,736 in 1913-14. The total trade of Canada with Germany in 1913-14 amounted to $19,019,969. In 1914-15 it amounted to $7,248,996. This year it will be nil. The "Balance of Trade" which is in this country's favor by about $6,000,000 will be largely increased during the present fiscal year.

The following table published by the London *Daily News* and leaded, is interesting and directs attention to the population and resources of the belligerents as follows:—

| *Nation* | *Population* | *Resources* |
|---|---|---|
| British Empire | 439,000,000 | $2,245,000,000 |
| Russia | 174,000,000 | 1,700,000,000 |
| France (with colonies) | 80,000,000 | 1,100,000,000 |
| Italy | 38,000,000 | 565,000,000 |
| Japan | 53,000,000 | 325,000,000 |
| Belgium (including the Congo) | 7,500,000 | (unstated) |
| Servia | 3,000,000 | 42,500,000 |
| Montenegro | 500,000 | 2,500,000 |
| Total | 795,000,000 | $5,980,000,000 |

Against these forces are aligned:

| *Nation* | *Population* | *Resources* |
|---|---|---|
| Germany | 65,000,000 | 875,000,000 |
| Austria | 29,000,000 | 700,000,000 |
| Hungary | 21,000,000 | 470,000,000 |
| Turkey | 21,000,000 | 85,000,000 |
| Total | 136,000,000 | $2,130,000,000 |

This table is interesting and the figures given sum up one result and that is final overwhelming triumph of the Allies.

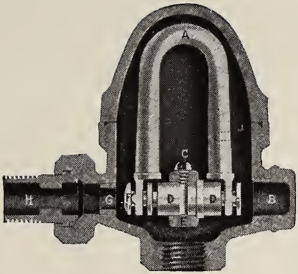
**F. M. Buchanan, B.A.Sc., '15,** has recently received the appointment as foreman on the Wayne County Concrete Roads, Michigan.

**T. R. Banbury, B.A.Sc., '15,** is with the Canadian Inspection Co., at the Empire Mfg. Co. Ltd., London.

**W. M. Currie, '04,** is vice-president and general manager of the Burlington Steel Company, Hamilton, Ont.

**J. Chalmers, '94,** is a consulting engineer. His address is 13012 104th Ave., Edmonton, Alta.

## A NEW RADIATOR TRAP



The thermostatic member used in this valve consists of a specially designed spring-tempered steel tube, heavily copper plated and contains a volatile fluid, hermetically sealed, which is so sensitive that a change of one degree is sufficient to start the valve in operation. This tube is held in a central position by a guide, cast solid with the body of the valve. A cap nut is provided on the side of the valve directly opposite the seat through which the valve mechanism may be inserted, or for testing the operation of the valve while it is in service.

The entire valve mechanism is mounted on a sleeve which acts as a guide for the valve head, and also supports and holds the thermostatic member so that the movement due to expansion and contraction must open and close the valve. This sleeve is supported and held in position by a bridge which is cast solid with the valve body. The valve head is of bronze and is so arranged that any movement of the expansion member will cause the valve head to move forward or back. The valve seat is a tempered bronze seat inserted into the body of the valve.

When steam is turned on, the thermostatic tube is neutral, under which conditions the valve is wide open, giving the full valve area. The valve remains in this position until all the air and condensation have been removed from the radiator (or point to be drained), but just the instant steam arrives, the tube expands, closing the valve absolutely tight. As condensation forms, the temperature lowers and the tube contracts, moving the valve from its seat, thereby permitting the condensation to be discharged.

Owing to the re-evaporation of the condensation when passing from a slight pressure to vacuum, the vapors from the hot water are sufficient to actuate the tube, thus preventing any measurable amount of vapor from passing through the valve. Attention is directed to the exceptionally large valve-opening. Any scale, sand or other foreign matter which may enter the valve drops to the bottom, and the valve seat being at the side and in a vertical position is thus kept clean and free from any foreign obstruction.

This valve is absolutely noiseless in operation, its construction makes it impossible for the valve head to flutter, and due to the fact that the valve seat is in a vertical position, foreign matter will not lodge on it and cause a hum due to the steam wire drawing.

These traps are manufactured by Wm. S. Haines & Co., Philadelphia.

# THE ENGINEERS

The ways of the Lord be manifold, He has fashioned divers men
To fret the Earth for a little space with labour, laughter and tears,
To strut in the light till the world forgets and buries them deep—and then
The Lord He stiffened His good right arm and fashioned the Engineers.

Where the naked ribs of the liner curve, and the straining rivets whine,
Where the plunging crosshead spatters the oil in the incandescent's glare,
Where the clanging coal scoop swings in the gloom, and the blistering clinkers shine,
Behold him—cool as an iceberg's foot—the Slave and the Master there.

When you come to the end of the old known land, to the far horizon's rim,
To the raw crude plain where the uplands lift and the mountains clamber sheer,
The small wise men of the ledger halt, and the call goes forth for him
Who laughs at the everlasting hills—the Master, the Engineer.

By lathe and chisel, by hammer and forge he is shaping the things that be,
He has harnessed the stream to his dynamo, he has said to the tides, "Beware."
He grubs in the echoing womb of the earth, and sits on the floor of the sea,
And rides athwart of the thunderstorm in the hollow caves of air.

Smooth and silent and very sure, he fingers the locking switch,
Where the yellow copper is glutted with death as it gleams on the marble wall,
And he turns on his heel when the red lamps wink, to balance his power and pitch
Through the gloom of the throbbing canyon streets the might of a water fall.

He weighs the world and the eye of a fly and he measures the light of a star,
And plays with a key at the end of a wire till the slumbering cities hear.
He whispers low and cradles his words on the curve of a waxen jar
That the bottom end of the earth may list to the voice of the Engineer.

He has come to grips with eternal truth, and he dallies not with lies;
He has ravished his mind of its small conceits and he knows not how to shirk,

For the Thing—the ultimate perfect Thing, is glimmering in his eyes
And a voice, a small reiterant voice, is whispering—"Will it work?"

When we come in time to the end of the road, to the step of the Golden Gate,
We shall see a fellow in overalls, and he'll probably stop and peer
To see how the gate is built, and then, if we only watch and wait
We shall notice him oiling the golden hinge—the beggar—the Engineer.

Alan Sullivan, S.P.S., '89, in Popular Magazine.

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## PERSONALS

**W. G. Collinson, B.A.Sc., '09.** His address is 532 4th St., Niagara Falls, N.Y.

**R. J. Campbell, '95.** His present address is 1218 Corn Exchange Bldg., Chicago.

**A. J. Campbell, B.A.Sc., '04,** resides at Collingwood, Ont.

**H. R. Carscallen, B.A.Sc., '08,** is assistant hydrographer in Irrigation Branch of Department of Interior at Calgary.

**A. Cameron, '06.** His present address is care of Provincial Architect's office, Winnipeg.

**A. B. Crealock, B.A.Sc., '15,** is draughting for the Toronto Rapid Transit. His address is 61 Geoffrey St., Toronto.

**Geo. F. Dalton, B.A.Sc., '14,** is on Geodetic Survey work with the Department of Interior. His address is 342 McLaren St., Ottawa.

**W. L. Dickson, B.A.Sc., '15,** is with the Canadian Inspection Co., at the Empire Mfg. Co., Ltd., London, Ont.

**E. R. Frost, B.A.Sc., '09,** resides at 159 Wentworth St. N., Hamilton.

**H. P. Frid, '11,** is a member of the firm James Frid & Co. Ltd., consulting engineers, Hamilton. His address is 607 Bank of Hamilton Bldg., Hamltion.

**H. J. Franklin, B.A.Sc., '14.** His permanent address is 72 Delaware Ave., Toronto.

**J. S. Galletly, B.A.Sc., '07,** resides at Osahwa, Ont.

**R. S. Houston, '06,** his present address is care of Dominion Bridge Co., Ltd., Winnipeg.

**L. J. Hayes, '03,** now resides at 2434 Niagara Ave., Niagara Falls, N.Y.

**R. A. Henry, B.A.Sc., '13,** is with the Maritime Bridge Co. of New Glasgow. His address is Box 1017, New Glasgow, Nova Scotia.

**J. E. Hanlon, B.A.Sc., '15,** is a surveyor for the Hollinger Mine at Timmins, Ont.

**Dion S. Halford, B.A.Sc., '15,** is with the Consolidated Arizona Smelting Co., Humboldt, Ariz.

**E. W. M. James, B.A.Sc., '09,** now resides at 445 Rosedale Ave., Winnipeg, Man.

**K. A. Jefferson, B.A.Sc., '15,** is with the Canadian Inspection Co. at the Empire Mfg. Co. Ltd., London.

**J. A. Knight, B.A.Sc., '14,** formerly with the Foundation Co. of Montreal, has enlisted with the Third Cyclist Corps.

**E. J. Laschingle, B.A.Sc., M.E., '92,** is hydraulic and air power engineer with the Central Mining & Investment Corporation Ltd. His address is Box 4563, Johannesburg, S. Africa.

**R. W. E. Loucks, '09,** is inspector of surveys, Land Titles Office, Surveys Branch, Regina, Sask.

**R. E. Lindsay, B.A.Sc., '14,** residence, 282 Ossington Ave,. Toronto.

**J. T. Mogan, B.A.Sc., '15,** is on the Toronto Harbour Commission work.

**J. M. Muir, B.A.Sc., '15,** is with the Department of Education, Toronto.

**J. A. MacMurchy, '96,** address is 1315 Elm Street, Wilkinsburg, Pa.

# C.O.T.C. MEN WHO PASSED THE OFFICERS' EXAMINATIONS

Out of seven hundred University men who wrote on the examinations of the Canadian Officers' Training Corps, only 153 passed. This was due to the examinations being much more severe than formerly, and not because of the rumored differences between the C.O.T.C. and military authorities. The following is the list of successful candidates:—

L. S. Aldard, D. R. Agnew, J. W. Ansley, R. H. Barbour, V. A. Beacock, S. Beatty, E. G. Berry, C. H. Black, A. S. Bourinot, W. F. Bowles, H. S. Brewster, J. C. W. Broom, L. A. Broughton, H. D. Brown, P. B. Brown, R. A. Brown, G. F. Bryant, J. T. Burns, T. D. Campbell, J. R. Cockburn, G. M. Dallyn, W. A. Dean, S. H. Dixon, G. P. Dunstan, C. Feeney, C. B. Fisher, E. M. Fraser, R. A. Fraser, F. H. Galpin, J. A. Garvie, J. A. Gilchrist, R. V. Gordon, D. S. Graham, H. H. Graham, H. C. Green, E. W. Haldenby, C. W. Harris, R. M. Harvey, W. J. Hearst, J. E. Hill, F. W. Hepwell, A. M. Horner, E. Howell, A. H. Isbister, T. H. Jamieson, A. M. Jeffrey, F. M. Johnston, G. W. F. Johnston, F. B. Kenrick, G. W. Kaiser, J. A. Kingsmill, W. W. Lang, G. W. Lawrence, H. O. Leach, H. B. Little, M. I. Machell, D. Maclean, J. P. Magwood, J. A. R. Mason, A. W. McConnell, W. R. McGie, H. C. McKendrick, A. P. McKenzie, D. S. McPherson, J. H. Moxley, J. M. Muir, J. G. Murray, F. S. Parney, G. Pilkey, J. R. Pounder, J. D. Relyea, W. W. Ritchie, C. C. Robinson, B. J. Roberts, H. M. Rowe, R. A. Seymour, J. E. Sharman, W. L. Sagar, M. R. Shier, K. G. Sinclair, W. E. Smith, W. J. Southcombe, W. A. Steele, E. C. Tate, W. D. Thomas, H. R. Thomson, W. M. Treadgold, H. D. Wallace, A. L. Ward, H. S. Weldon, R. H. Williams, W. J. T. Wright, H. H. Wrong, L. E. Willmott, L. L. Youell, J. R. Robinson, W. Hegers, J. M. Aylward, W. H. Bonus, B. D. Carlyle, J. M. Cunningham, H. A. Elliott, J. A. Harston, J. R. Manning, L. M. Murray, R. B. Pichard, G. A. Snow, J. S. Wear, K. A. Jefferson, W. H. R. Gould, G. K. William, R. L. Killock, G. Rosser, A. L. Huether, G. W. Brown, T. M. Kerruish, E. Machell, H. C. Budd, W. A. Smelser, W. L. Dobbin, C. R. McCort, A. Chambers, F. L. Mitchell, C. R. Albright, W. T. Miller, J. S. Beatty, A. M. Boyd, F. C. Carter, R. S. Cassels, W. W. Davidson, M. L. Ellis, A. M. Garden, J. N. Garrow, E. L. Greene, R. W. Hart, J. S. Hodgson, R. A. Laidlaw, H. E. Manning, K. F. McKenzie, N. M. McLeod, W. B. McPherson, W. W. Parry, C. F. Ritchie, H. D. Scully, A. C. Snively, C. L. Wilson, E. V. Graham, C. B. Scott, H. P. Stewart, R. P. McCormack, R. B. Whitehead, D. W. Lang, D. B. Gillies.

### DAVISON-HASTINGS

At Pittsburgh, Pa., in September, 1914, H. D. Davison, B.A.Sc., '13, of Bridgewater, Nova Scotia, was united in marriage to Miss Helen Hastings of Pittsburgh, Pa.

### HAYES-O'BRIEN

At Albany, New York, on May 29, 1915, L. Joseph Hayes, '03, of Toronto, was united in marriage to Loretta M. O'Brien, of Albany, N.Y. Mr. and Mrs. Hayes will reside at Niagara Falls, N.Y.

### DAVISON-MARSHALL

In January last at Bridgewater, Nova Scotia, Mr. R. F. Davison, '13, was united in marriage to Miss M. Marshall, of Annapolis, Nova Scotia.

### SARA-HANNA

Mr. and Mrs. A. E. Hanna, 1123 Grosvenor Ave., Winnipeg, announce the engagement of their only daughter, Evelyn B., to Mr. Richard A. Sara, B.A.Sc., E.E., '09, youngest son of Mr. and Mrs. J. H. Sara, Toronto. The marriage will take place on September 29th.

### SHEARER-PUGSLEY

Rev. Will and Mrs. Pugsley, Yorkville Ave., announce the engagement of their daughter, Bessie May, to Mr. Harry Foster Shearer, B.A.Sc., '08, Toronto, son of Mr. and Mrs. Charles E. Shearer, Vittoria, Ont. The marriage will take place early in September.

### PENNINGTON-CHIPMAN

Mr. and Mrs. Willis Chipman announce the engagement of their daughter, Gertrude Elma, to Charles Wakley Pennington, B.A.Sc., '14, of Dundas. The marriage will take place quietly early in September.

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**C. P. McGibbon, '04,** resides at 124 James St., Hamilton.

**V. McMillan, B.A.Sc., '09,** is with the Canadian Inspection Co. at the Empire Mfg. Co., London.

**O. B. McCuaig, B.A.Sc., '04,** C.Q.M.S. No. 5302, No. 2 Field Co. Divisional Engineers, First Contingent, Army P.O., London, Eng.

**H. C. McMordie, B.A.Sc., '08,** formerly with the Trussed Concrete Steel Co. at Winnipeg, has volunteered for overseas service and we believe he received a commission with a Winnipeg battalion.

**O. W. Martyn, B.A.Sc., '09,** is a member of the firm Martyn & MacDonald, civil engineers and surveyors. Address, Box 443, Swift Current, Sask.

**A. W. R. Maisonville, B.A.Sc., '10,** is with the Dominion Bridge Co., Montreal.

**C. R. McCort, B.A.Sc., '15.** Address, 519 Clark Ave., Westmount, Que.

# EDITORIAL COMMENT

**NEW SUBMARINE ENGINES**

In this great war for humanity which is being waged in Europe, one thing stands out above all others: namely, that this is primarily a war waged by machines against machines. Mechanical genius is now being refined in the great crucible of immediate adaptability to present ends. The weak or fundamentally incorrect is tried and immediately wasted. The strong is improved and adapted to further uses. Above all the germ of new ideas is being sought, and it may be that in the utilization of compressed air for propelling the submarine when submerged Mr. Tygard has presented a new line for experiment. We have just the rough outline of the idea presented to us in the present article and can only hope for a fuller demonstration in the future.

There are two or three points worth considering, however. Granted the fact of noxious gases from electrical storage batteries, of what increased purity would the compresed air be after being exhausted from the rotary air engine? Again is it possible in the same time to store the same working quantity of energy in the air as could be stored in batteries. Further would not the exhaust from such an engine very materially lower the temperature of the submarine even to the point of frigidity? Another interesting point which would call for explanation is how the exhaustion overboard of the gases from the oil engine is to be accomplished given the air pressure in the submarine as excessive and the craft submerged. Would it not be as practical, if at all possible, to exhaust the air direct?

All of these questions bear vitally on the feasibility of the idea. They have, no doubt, been met by Mr. Tygard from the outset, and we await with interest a more complete description.

**BOARD OF ENGINEERS**

Has the engineering body of Canada realized as a whole that this war is to be to a finish and that that finish is far away? Have they appreciated the fact that before this war is over conditions in Canada must come to that of England at the present time. Everything will have to be made subservient to the war,—bridges, buildings, paving streets, municipal works of all sorts, must all eventually become of secondary importance? What can the engineers do? At least a partial answer to this is not hard to find.

England at the present time is being gone over with a fine toothed comb by the British Munition Department and its auxiliary advising boards. Factories of all kinds are being adapted to the manufac-

# EDITORIAL COMMENT

ture of war supplies,—cloths, guns, ammunition, and equipment. Matters are to an extent being taken out of the owners' hands because of necessity. What is the result but that a more cheerful spirit is pervading the country and order is coming into being.

Take the United States, a country not at war, and from present indications not likely to be. Secretary of the Navy Daniels has announced the formation of a board of the most eminent creative geniuses of that country, headed by Thos. A. Edison; for what purpose? To apply their gifts to the improvement and perfecting of the arms of the United States. All this, mind you, before war is contemplated.

Now let us look at Canada. We have done wonders. From a production of munitions practically nil we have attained an output of over 25,000 shells per day. We have the best aeroplane engineers working constantly. Our woollen mills are keeping up with present demands. But what more might be done? Ammunition and guns with more ammunition is the cry from Europe and we pat ourselves on the back and point to our present output. But here is the chance for Canadian engineers to do something patriotic. At present a manufacturer, before he can obtain a contract for munitions, has to satisfy the authorities of his ability to fulfil that contract. He is put to the trouble of engaging engineering skill to rearrange his plant to meet new conditions. These alterations are made in no standard way, and as has often been the case, have had to be further revised.

Why should the engineers wait for the Canadian Government to move towards lending a hand to all those plants which might aid in the production of war supplies. Why do they not rather approach the government and show the need for concerted and thoughtful action. What is needed is a business like stocktaking of all the possible sources of manufacture in Canada. Then the best engineering brains of Canada under Governmental control and working to the Government's own specifications, should step in and take charge of the alterations for the owners and carry the work to a speedy and correct end. An engineering body of this kind working with complete information could accomplish wonders in Canada and this concentration of energy would not stop there. It would awake the country as in no other way, to the seriousness of the time. It will ultimately come, but why wait for governmental action? Canada has the engineers, and if they have a proper understanding of the word "patriotism" it is up to them to impress the government with the need for immediate scientific action, in remantelling our manufactures, etc., for the present work of the Empire.

# EDITORIAL COMMENT

**ATTENTION OF ALL**

As a means of increasing the "get-together" spirit of "School" men, now that the Exhibition is on, let us ask each and every graduate to call at the office of the Society in the Old Red Building and make themselves known while in town. Make this office the headquarters for your stay and utilize the conveniences of the Society at this time. Our new and comfortable smoking room, in which you will find all the daily papers are at your disposal, as is also our library. Get in touch with the other fellow once more; find out what is being done by the Society; learn the problems we are trying to meet and let us profit by your experience and advice. All graduates anticipating a visit to the city at this time are requested to send their name and probable city address for our Exhibition registry and we will do what we can to get you in touch with other School men. *The office is open every day from 9 a.m. to 5 p.m. (excepting Saturday, and the telephone number is College 5000.* The West door *only* is open.

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## ON ACTIVE SERVICE

**G. R. Johnson, B.A.Sc., '13,** with the King Edward Horse, Machine Gun Division, 12th Brigade B. E. Force.

**Grant Gooderham, B.A.Sc., '15,** and **R. D. Delamere, B.A.Sc., '14,** have completed their flying course at Toronto and received their commission in the Imperial Service.

**G. K. Williams, B.A.Sc., '10,** has joined the Aviation Corps.

**C. Hewson, '17,** with the Aviation Corps.

**Geo. G. MacLennan, '10,** has enlisted for overseas service with the Aviation Corps.

**J. A. Knight, B.A.Sc., '14,** has enlisted with the Third Overseas Cyclist Corps, which is being recruited from the Corps of Guides.

**Lieut. E. V. McKague, B.A.Sc., '15,** has received a commission with the Third Overseas Cyclist Corps.

**Capt. G. B. Schwartz, '16,** is in command of the Third Overseas Cyclist Corps.

**Lieut. R. D. Galbraith, B.A.Sc., '15,** has received a commission in the 92nd Battalion with the Queen's Own.

**H. C. McMordie, B.A.Sc., '08,** we believe, has received a commission with a Winnipeg Battalion for overseas service.

**Lieut. A. P. Linton, B.A.Sc., '06,** has received a commission with the 68th Battalion C.E.F. at Regina, Sask.

**Lieut. R. K. Northey, B.A.Sc., '11,** is also with the 68th Battalion recruiting at Regina, Sask.

---

**Wm. A. O'Flynn, B.A.Sc., '11,** has accepted a position as 2nd chemist for the Mond Nickel Co., Coniston, Ont.

**J. J. Philips, B.A.Sc., '13,** is installing machinery for Abitibi Power & Paper Co., Iroquois Falls, Ontario.

**J. A. Ryckman, '06,** is field engineer on the Bloor St. Viaduct, Toronto. Address 300 Clendenan Ave., Toronto.

**D. C. L. Raymond, B.A.Sc., '04,** is with the Raymond Construction Co. of Montreal, who are doing concrete work in connection with the Rosedale section of the Bloor St. viaduct.

# UNKNOWN ADDRESSES

## OUR READERS WILL CONFER A FAVOR IF THEY WILL KINDLY ADVISE US OF THE CORRECT, OR MOST RECENT KNOWN ADDRESSES, OF ANY OF THE MEN LISTED BELOW

Acres, H. G., '14.
Alexander, J. H., '04.
Barrett, J. H., '03.
Bertram, G. M., '01.
Binns, R. E., '13.
Boswell, W. O., '11.
Boulton, W. J., '09.
Burgess, J. R., '10.
Bowman, A. M., '86.
Brackenreid, '11.
Brown, D. B., '88.
Brown, H., '11.
Brown, E. I., '08.
Brown, E. W., '09.
Bruce, W. J., '07.
Burnham, F. W., '04.
Cameron, M. G., '09.
Campbell, A. W., '06.
Campbell, J. E., '08.
Carey, B., '99.
Chambers, E. V., '14.
Chantrell, E., '05.
Charlebois, J. P. C., '08.
Chisholm, D. C., '10.
Christie, V., '06.
Clark, G. T., '06.
Clendenning, A. C.
Coulter, G. P., '07.
Darroch, J., '08.
DeGuerre, F. C., '11.
Derham, W. P., '09.
Dowling, F., '05.
Elliott, J. C., '99.
Evans, J. H., '11.
Evans, S. D., '07.
Evans, S. L., '08.
Flynn, C. C., '11.
Foreman, W. E., '99.
Forester, C., '93.
Francis, C. C., '08.
Gray, J. E., '09.
George, R. E., '03.
Gourley, W. A., '03.
Harris, H. C., '13.
Heebner, M. B., '11.
Horton, J. A., '03.
Holmes, H. E., '11.
Hull, H. S., '95.
Johnston, G. K., '03.
Jones, G. R., '06.
Kean, D. L., '09.
Keefer, A. H. E., '09.
Keys, W. R., '08.
Killip, W. C., '08.
King, C. F., '97.
Lawson, W. L., '92.
Lott, A. E., '87.
Macdonald, F. R., '08.
Macdougall, A. C., '01.
MacFarlane, E. D., '09.
McKay, A. G., '07.
McKay, J. T., '02.
McKenzie, D. W., '05.
MacLachlan, W. A., '09.
McLean, W. N., '05.
McLeod, G., '09.
McLeish, A. G., '11.
McPherson, J. A., '06.
Macpherson, N. W., '09.
McTaggart, A. L., '94.
Malone, J. E., '08.
Martin, F., '87.
Matheson, W. C., '01
Maus, C. A., '03.
Mennie, R. S., '02.
Milligan, G. L., '08.
Mitchell, L. C., '11.
Montague, F. F., '06.
Munro, F. V., '03.
Murray, J. D., '07.
Niebel, E. H., '11.
Nourse, A. E., '07.
O'Brien, E. D., '05.
O'Gorman, C. A., '09.
Oliver, J. P., '03.
Parke, J., '04.
Paton, T. K., '07.
Paulin, F. W., '07.
Pearce, K. K.
Pearson, C. L., '11.
Pope, A. S. H., '99.
Roaf, J. R., '00.
Sanders, W. K., '06.
Shipley, A. E., '98.
Shortt, J. H.
Smith, F. L., '10.
Squire, G. E., '11.
Stamford, W. L., '08.
Stuart, J. L. G., '07.
Szammers, C. F., '11.
Taylor, J. W. R., '08.
Thomas, V. C., '08.
Thomson, J. E., '06.
Venney, L. T., '06.
Williamson, D. A., '98.
Wilson, F. F., '09.
Wilson, W. H., '10.
Wilkes, G. H., '11.

## PERSONALS

**D. F. Robertson, D.L.S., '04,** is surveyor in the Department of Indian Affairs, Ottawa.

**H. L. Roblin, B.A.Sc., '11,** is with the Canadian Inspection Co., at Galt. Address care of Y.M.C.A.

**H. A. Ricker, B.A.Sc., '08.** Residence, 93 Sanford Ave., S., Hamilton.

**C. C. Rous, B.A.Sc., '13,** resides at 59 St. Cyrille St., Quebec.

**A. A. Richardson, B.A.Sc., '15,** has recently accepted a position in charge of some harbour work for the Canadian Stewart Co., Toronto.

**N. H. Sturdy, '05,** residence, 426 Emerson Place, Youngstown, Ohio.

**G. C. Story, B.A.Sc., '15,** is with the McCormick Mfg. Co. Ltd., London, as electrician. Address 579 Colborne St., London, Ont.

**H. V. Serson, '05.** Address, Box 107, Arnprior, Ont.

**W. Snaith, '07,** is with the Thor Iron Works Ltd., Toronto.

**P. H. Stock, '09.** Address 12 Fernwood Park Ave., Toronto.

**K. E. Shaw, B.A.Sc., '13,** is with the Dominion Sugar Co. Ltd., of Wallaceburg, preparing plans and estimates for a proposed 1,200 ton sugar beet factory to be erected at Chatham.

**P. M. Sander, '04,** is chief hydrographer in the Irrigation Branch of Department of Interior at Calgary. Address P.O. Drawer 2318, Calgary.

**R. O. Standing, B.A.Sc., '14,** is with Goldie & McCullough Ltd., Galt. His address, 40 West Main St. North, Galt.

**M. L. Smith, B.A.Sc., '11,** formerly associate editor for MacLean Publishing Co., Toronto, has accepted the position in charge of engineering at the New Technical School, Toronto.

**W. H. Stevenson, B.A.Sc., '01,** is secretary of the Power Plant Specialty Co., Monadnock Block, Chicago.

**C. P. Sills, B.A.Sc., '11,** is now at Seaforth, Ont.

**E. H. Scott, B.A.Sc., '15,** is guiding tourists throughout northern Ontario for the summer.

**R. G. Scott, B.A.Sc., '15,** is on geological survey work around Revelstoke.

**J. B. Stitt, B.A.Sc., '15,** is with the Braden Copper Co., Rancagua, Chile, South America.

**J. E. C. Stroud, B.A.Sc., '15,** is assistant chemist on smelter at Anyox, B.C.

**H. W. Tye, '08,** is now at Balcarres, Sask.

**W. V. Taylor, '93,** is principal assistant engineer to the Quebec Harbour Commissioners.

**T. L. Villeneuve, '08,** is with the Department of Public Works, Chicoutimi, Que.

**O. T. G. Williamson, B.A.Sc., '09,** resides at 1345 North Shore Ave., Chicago, Ill.

**F. H. Wrong, '11,** resides at 355 Bedford St., Sandwich, Ont.

**J. A. Whelihan, '03,** is ranching somewhere in the west. Try Box 165, Regina, Sask.

**H. A. Wood, B.A.Sc., '15,** is in charge of surveys for the Eastern Division of Toronto Harbour.

## DIRECTORY OF THE ALUMNI

**Gibson, M. M.,** '10, and **Gibson, W. S.,** '04, are members of the firm Gibson & Gibson, civil engineers and surveyors, Toronto.

**Gibson, N. R.,** '01, 550 Confederation Life Building, Toronto.

**Gillespie, P.,** '03, is associate Professor, Department of Applied Mechanics, University of Toronto.

**Gillies, A.,** '07, is with the C.N.O. Ry. at Quebec, Que.

**Glover, A. E.,** '09, is engaged in surveying in Edmonton, Alta.

**Goad, V. A. E.,** '10, is a partner in the firm of the Chas. E. Goad Co., surveyors and civil engineers. He was in charge of their Montreal office when last heard from.

**Goldie, A. R.,** '93, is a member of the firm of Goldie & McCulloch Co., Limited, Galt, Ont., as manager.

(*Continued on page x*)

Applied Science

INCORPORATED WITH

TRANSACTIONS OF THE UNIVERSITY OF TORONTO
ENGINEERING SOCIETY

Old Series Vol. 27 TORONTO, JUNE, 1916 New Series Vol. X. No. 5

# THE UNIVERSITY AND INDUSTRIAL RESEARCH

By Dean W. H. Ellis

Among the treasured possessions of the library of the University is a set of the Annales de Chimie, the gift of the seventh Duke of Devonshire through the Committee formed in the Old Country to aid in replacing the loss caused by the disastrous fire of February 14th, 1890.

The set is complete from beginning of the series to the date of the fire and on the fly-leaves of the earlier volumes is stamped the honoured name of Henry Cavendish, who was the grandson of the second duke.

The first volume, as we read on the title page, was conducted by M. M. Guyton de Morveau, Lavoisier, Mouge, Berthollet, de Fourcroy, le baron de Dietrich, Hasenfratz and Adet. In 1791 the editors became Mm. Guyton ci-devant de Morveau. Dietrich had dropped his title of baron and de Fourcroy the aristocratic "de." Then follows a gap during which the Annales were not published and when in 1797 the editors' names again appear as les citoyens Guyton, Mouge, Fourcroy and the rest, the name of Lavoisier is not among them for that gap in her annals is the record that science has made of the Terror and the Terror had sent Lavoisier to the guillotine with the mocking words, "The Republic has no need of savants." From this delirium the Republic quickly awoke and her penitence for her murdered savants was bitter and sincere.

The avant-propos of the volume of the Annales de Chimie for the year V. of 1797 reads as follows:—

The Annales de Chimie have been interrupted for three years after the publication of the 18th vol. The necessity of occupying oneself solely with the defense of the Republic, the events of the revolution, the public functions of the authors, are the natural causes of this suspension. But the time has not been entirely lost for science. Chemistry above all has been cultivated with a success of which all citizens have been witnesses. She has created for the defence of the fatherland resources and means truly unexpected. Her immediate utility for the most pressing needs of society renders her more precious and commendable than ever in the eyes of the friends of mankind and of all good, true citizens. Also the number of those who study chemistry increases every day; also it becomes one of the bases of instruction in all modern schools and above all in those which attain to the highest degree of human knowledge.

Among all the civilized nations where one works without relaxation in perfecting reason (ou l'on travaille sans relâche au perfectionnement de la raison) the sciences which influence territorial and industrial productions, and among which chemistry holds to-day the first rank, are held in general esteem. The cultivation of the fields, the multiplication of animals, the establishment of manufactures, the exchange of the creations of industry for the production of other peoples,—these are the true sources of the prosperity of nations in which all men are called to assist and where each will find his private enjoyment in serving his country.

Chemistry illuminates the practice of the arts; without it one can neither hope for constant products nor economy in processes nor perfection in operations. From failure to appreciate the advantages of chemistry and to make themselves acquainted with its results, manufacturers have often committed errors which have cost them the loss of their establishment. Within the last few years a mere handful of clever chemists have become manufacturers and already a crowd of processes have been rectified; and new arts have been created. France has ceased to be tributary to other nations for a great number of useful products. The preparation of mineral acids, of the different salts, of metallic oxides, the dye works, the glass works, so multiplied in France in the last fifteen years are authentic proofs of the unappreciable advantages of chemistry. Without the light of this science should we have made the quantity of saltpetre, of gunpowder, that we have manufactured in the last four years? Should we have had the copper, the iron, the steel, the potash, the soda, the leather and so many other precious materials which we have employed to vanquish our enemies and to sustain our existence? Without chemistry should we have wrought to perfection as we have done—aerostation?

At the moment when victory has crowned our efforts, when a wise constitution has fixed the lot of France, when talent is honoured there and called to serve the country; at the moment above all when new schools are arising in the departments and are going to spread education and make the need of it felt on every hand, the authors of the Annales de Chimie believe that the need is pressing that they should continue their work. Their aim will be to carry the torch of science into all the workshops; to introduce new processes; to describe the arts less known or even entirely unused in France, to improve vicious practices; to rectify the errors still too numerous in many manufactures; to give the means of employing in useful preparations a crowd of substances hitherto too much neglected or even allowed to be lost; to disperse the secrecy of the workshops often deceptive, and their charlatanism always perfidious; to establish the clearest theories of the most obscure operations; to direct the steps almost always hesitating and uncertain of the workman; to destroy mystery and to repel fraud; in a word, to employ one of the most exact sciences in the multiplication of all the objects of national industry. Without neglecting philosophical chemistry they will apply themselves specially to industrial chemistry, to that which creates, which illuminates and which brings to perfection the arts. They will not repulse brilliant and ingenious theories; but they will above all present their useful applications. It is to artists, to manufacturers and to intelligent artisans, to enlightened and honourable business men, for whom they particularly destine this work. Scientific men and philosophers will find there at the same time all the progress of physics and the advances of the human reason. It is obvious that in improving the arts among a great people, one improves at the same time the reason of man.

It is not necessary to say that we have combined all possible means to join to the discoveries of the French those which have been made in all the other nations in which chemistry and the chemical arts have been cultivated with success, and above all in Germany, in Spain, in Holland, in Italy and in England. The authors of the Annales de Chimie, having resumed their work, propose to unite in two volumes which will form the nineteenth and twentieth of the collection, the principal discoveries made and most remarkable work in Chemistry done in France from the month of September, 1793 to the month of January, 1797.

The contents of the volume to which these remarks form the preface were:

1. A notice to workers in iron on the fabrication of steel in which the physical and chemical properties of iron and steel are described and the methods of its production in England and elsewhere are given.

2. Then follows a description of the methods of fabrication of armes blanches at Klingenthal in Alsace with details of the manufacture of sabres and bayonets, ramrods, etc.

Then comes a report by Pelleher and others on various methods of obtaining soda from common salt, first of which is that of citizen Leblanc, presented by him with a noble devotion to the public good.

3. Memoir on the means of multiplying the fabrication of potash in France.

Instructions for obtaining paper by working up printed or written sheets.

9. Report on the manufacture of soap.

10. Extract from a report on attempts made at Romilli to separate the copper from bell metal.

11. Instructions as to the new Republican weights and measures.

12. On the extraordinary production of saltpetre in France during years 2 and 3 of the Republic.

13. Test on a grand scale made in the Russian army on the purification of water by powdered charcoal.

In these words the infant Republic made its confession of scientific faith. The position of the British Empire to-day resembles in some respects that of the French republic at that time. Against her were arrayed the trained armies of Austria and Prussia and she was forced to strain every nerve to improvise an army, to arm it, train it and provide it with munitions. If we, like revolutionary France, hope to rise triumphant from the crisis in which we now find ourselves, we must, like her, call to our aid organized science. Scientific men our race has produced in abundance and these of the highest eminence, whose contributions to science, pure and applied, have been of the first importance. But of organization in scientific matters we have lagged behind and in particular we have been outdistanced by our enemies, the Germans.

There is no need to emphasize this. It has been dinned in our ears by friend and foe alike, but it must be insisted on that our inferiority in the application of science to industry, where there has been failure, has not been due to lack of genius or to lack of knowledge, but to other causes, partly educational, partly economical and partly political.

The raison d'étre of a university is to see to it that there may never be wanting a due succession of persons duly qualified for the public service.

The English idea of public service is the church, the bar and parliament, and the university ideal training has been the training that will qualify a man for success in those walks,—in short the power of speaking or writing convincingly.

In Germany where the power of popular assemblies was a negligible quantity the university ideal was quite another. In Germany men looked for success, not from the pleasure of a mob, whether that mob was called a jury, a congregation, or a parliament, but from the approval of their superiors, from experts, that is such as judges and heads of departments. Under these circumstances the key to success is efficiency, ability to do things, not fluency in talking about them. Efficiency then has been the ideal of the German universities.

Now in a very large number of cases the proprietors and directors of the German industrial establishments had been educated in one of these universities and when they required scientific advice they naturally looked to a member of the university for this advice and more than this, their education enabled them to appreciate this advice when it was given. They and their scientific advisors had the same point of view. They could understand each other's reasoning and appreciate each other's mental attitude. To this sympathy between the business manager and the scientific expert in his employ is to be attributed in a very large measure the successful application of science to agriculture in Germany.

What can we in this University do to promote and foster such a sympathy between the laboratory and the workshop, between the technical graduate and the foreman and superintendent?

First, we must give our students the best possible grounding in pure science and secondly, we must shew them the way to find out new things for themselves.

The University must, like a parent bird, nourish her brood by an abundant supply of suitable food, industriously gathered, selected and, if necessary, predigested, but when the nestlings are ready for flight she must guide and exercise by precept and example their unaccustomed wings till they are ready to shift for themselves and their wings are strong and fit for their bold and adventurous flight into the unknown.

The Faculty of Applied Science and Engineering of the University of Toronto can point with pride to the work of its graduates and to the positions they have won in the Province and outside it as testimony that they have in the past been not unfaithful to the trust which the Province has reposed in it. But we feel that this is no time to rest upon our laurels. If we are to rise to the supreme demands of the present crisis and to its unique opportunities we must take some definite step forward in the direction of the encouragement and organization of industrial research. It appears to many of us that the most hopeful course in our immediate future would be the foundation of a School of Engineering Research, properly equipped, properly supported and directed by those among us who have shown themselves capable of leadership in this direction.

It is to be hoped that some such scheme will commend itself to the authorities for immediate adoption.

## RETIRING PRESIDENT'S ADDRESS

Gentlemen,—As retiring president of the Engineering Society, I wish to thank you for your hearty co-operation and support during this past year. It has been a year without parallel in the history of the School, as also it has been in the world at large. You have stood by the executive, and rallied around us with the School spirit in a way that has never before been equalled.

Our meetings this year, in spite of greatly decreased attendance at the School, were successful throughout. They comprised the addresses given by A. H. Harkness, '95, on St. Andrew's "Movable Dam;" J. A. D. McCurdy, '07, "Aviation;" Lieut. (Prof.) T. R. Loudon, '05, "Military Engineering;" D. A. Molitor, C.E., "Surveying as Taught at Cornell University;" Lieut. M. B. Watson '10, of the Royal Engineers, on leave from France, who gave us a vivid account of engineer's work at the front.

The Annual Dinner held on February 4th, was one of the most successful functions ever held at the School and it was unique in every regard. One outstanding feature was the hearty support which you undergraduates gave the executive, probably for the reason that it was the last opportunity which many of us would have to be present at such an occasion. The dinner was also a success financially, and this will, I hope, form a precedent for the years to come.

* * *

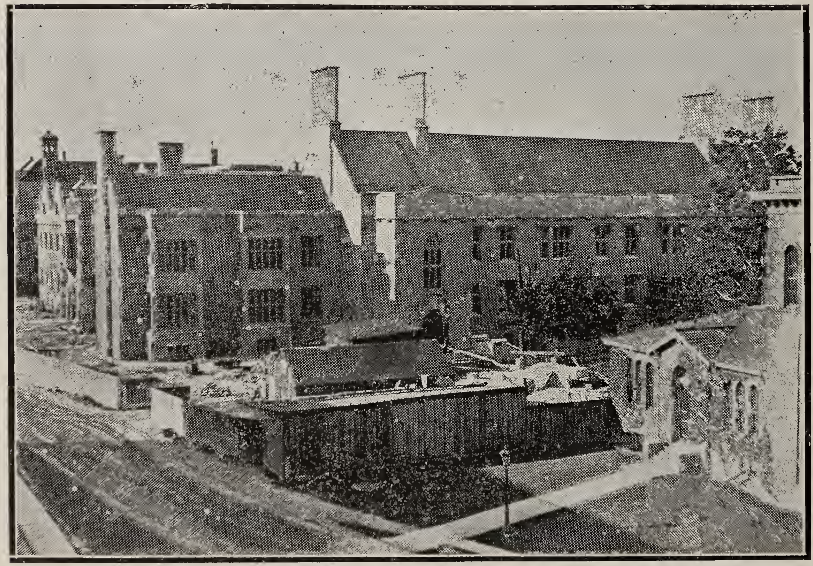
Your thanks, gentlemen, are due to the Faculty for the deep interest taken by them in the Engineering Society, particularly to Dean Ellis, to a committee composed of Prof. H. E. T. Haultain, Prof. P. Gillespie, Prof. J. W. Bain and Prof. W. H. Price, appointed by the Council to aid the Society when we were in difficulty; and to Prof. C. H. C. Wright. These gentlemen have given time and thought, and invaluable assistance in the interests of the Society, and our debt to them is great.

We are also greatly indebted to Mr. J. L. Ross of this city, a past president of the Literary Society. At a time when the affairs of the Engineering Society demanded the most careful handling, Mr. Ross gave most generously of his time and advice in legal matters without any charge whatsoever.

Your executive committee has been an able and strong one. They have worked hard and to them belongs the credit for what may have been accomplished this year. In particular may I mention W. B. Honeywell, to whom as interim president, is due your sincerest appreciation. Through the efforts of Mr. Honeywell and the other members of the executive relations of the Society to its creditors have been placed upon a satisfactory basis.

It is a pleasure on your behalf to welcome Mr. Banigan, as president-elect for the coming year. You have conferred upon him the highest honor in the gift of the undergraduate body of this Faculty. The responsibilities of this office are great and I hope that the high standards set by his predecessors may be even eclipsed in the coming year. I congratulate you on your choice of a president and executive committee.

W. Leslie Dobbin.



Hart House Nearing Completion

# APPLIED SCIENCE

INCORPORATED WITH

**Transactions of the University of Toronto Engineering Society**

DEVOTED TO THE INTERESTS OF ENGINEERING, ARCHITECTURE
AND APPLIED CHEMISTRY AT THE UNIVERSITY OF TORONTO

Published by the University of Toronto Engineering Society

**ENGINEERING SOCIETY EXECUTIVE**

| | |
|---|---|
| W. L. Dobbin | President |
| W. B. Honeywell | Vice-President |
| R. S. C. Bothwell | Corresponding Secretary |
| K. J. McEachern | Recording Secretary |
| R. L. Shoebottom | Treasurer |
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| B. A. McCrodan | Chairman, Mining Club |
| J. R. Kirby | Fourth Year Representative |
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| J. H. McVean | Second Year Representative |
| L. J. Seibert | First Year Representative |
| A. B. Wood | Curator |
| G. G. Macdonald | Editor |

Address all communications:
Applied Science,
Engineering Bldg., University of Toronto,
Toronto, Ont.

## ENGINEERING SOCIETY AFFAIRS IN 1915-16

During the past year the Engineering Society has passed through a severe financial crisis. In July, 1915, Mr. R. G. Lye, who had been appointed secretary in April, was compelled to approach the graduates with the request for a loan of $500 to meet pressing obligations. A committee of graduates consisting of Messrs. E. W. Oliver, W. A. Bucke, W. B. Russel and H. E. T. Haultain undertook to secure the desired sum which was raised in the form of notes in Toronto, Montreal, Ottawa, Cobalt, Porcupine and New York. The necessary payments to creditors were duly made, and by October the notes given by the graduates had been entirely redeemed.

The financial condition of the Society obviously needed the most careful scrutiny, and after an audit had been made, the following facts became evident. The monthly issues of Applied Science had for some time past been published at a loss. This deficit was partly due to a falling off in advertisements as a result of the war, and partly to the fact that less than 50% of the graduates had paid their annual subscription.

Another important item on the balance sheet was "stock on hand." An inventory showed that some of the stock was very slow selling, an accumulated legacy in fact from several previous years.

Since 1907 a graduate had been employed by the Society as a permanent paid secretary and editor of Applied Science. During the years when the attendance was large the receipts from fees, the profits of the supply department, and the income from advertisements had been sufficient to appear to justify the payment of a salary. In 1915 the attendance had fallen and was still falling off steadily owing to the war and it became evident that the Society could no longer afford to carry on its business by the aid of a salaried official.

The above facts, together with the pressure of the creditors, led to a complete reorganization of the business methods of the Society. Under the expert guidance of Mr. J. L. Ross of the legal firm of Messrs. Ross & Holmsted, Toronto, the financial statement of the Society was laid before the chief creditors, and a working agreement was arranged by which the sums owing them were to be reduced pro rata as rapidly as possible, and some of the slow-selling stock was to be taken back by the creditors. Special efforts were made to decrease the amount of other dead stock, which met with considerable success.

The paid secretary resigned early in the session, and has not been replaced. The business has been carried on without loss of efficiency by the executive committee, with the aid of an assistant, Miss Dunlop, who assists in selling the goods and attends to most of the clerical work.

The publication of Applied Science was stopped in August, 1915. The present issue is the only one which it is intended to publish until after the war.

Owing to the resignation of the president at the beginning of the session, the vice-president, W. B. Honeywell shouldered the responsibilities during this difficult transition period. At a meeting of the Society held on November 17, 1915, W. L. Dobbin was elected president by acclamation. The cares of the office during the session have been particularly onerous and called for constant, unselfish effort. The affairs of the Society are now on a smooth running and efficient basis.

Communications from the Engineering Alumni Associations of Toronto and Ottawa have been received and are printed in this issue.

In Montreal there is a Toike Oike Club. In Cobalt, Haileybury, New Liskeard and Porcupine there is the Temiskaming Engineering Alumni Association. Both of these are alive and active. In New York there are a few ever interested and ever active graduates. In Pittsburg, Winnipeg, Vancouver there are or there have been recently active Engineering Alumni Associations. We are told that at one time in recent years there were twelve or thirteen organized associations. If there had been a central organization not controlling, but co-operating with branches, the benefit to the school, both graduates and under-gradutaes, would be continuous.

## ENGINEERING ALUMNI ASSOCIATION

Doubtless, many of the graduates of the School of Practical Science and the Faculty of Applied Science are not aware that such an organization as "The Engineering Alumni Association of the University of Toronto" exists; therefore, the Toronto Executive Committee welcomes this excellent opportunity of acquainting such graduates with the fact that there is in Toronto an active Alumni Association. The following account will give an idea of the organization and we hope it will stimulate the dormant interest of some graduates in "School" affairs so that they will line up behind a big effort to increase its sphere of usefulness. With the co-operation of the graduates, a strong organization will be developed.

Early in the nineties an Alumni Association had been formed but it had little or no active life and before long ceased to exist even in name.

In the year 1909 some active graduates realized that, in order to maintain the prestige of the graduates, some organization must be formed through which they could express their respective views on matters of vital interest to the welfare of the school. Consequently, a general meeting of the graduates was called and an executive committee elected. This committee prepared a set of by-laws, which were adopted at the next annual meeting. The first two clauses are as follows:—

Name. The name of this Association shall be the Engineering Alumni Association of the University of Toronto.

Objects. (a) To endeavor to increase the interest of the graduate body in University affairs looking to the still greater efficiency of the Faculty of Applied Science and Engineering.

(b) To hold frequent meetings for the promotion of social intercourse amongst the graduates, and for the discussion of matters affecting the interests of this Faculty and the graduate body.

(c) To institute the necessary representations to carry into effect the recommendations of the Association.

Two other clauses read:—

All business meetings of both the Association and of the Executive Committee shall be held in Toronto.

An annual fee of one dollar shall be requested from each member to provide funds for the petty expenses of the Association.

The Engineering Alumni Association of the University of Toronto thought it wise to extend their activities and undertook to create Research Fellowships. Among other clauses by-laws governing these fellowships contained the following:—

These fellowships shall be called "Research Fellowships in the Faculty of Applied Science and Engineering, University of Toronto."

The value of these fellowships shall be five hundred dollars ($500.00).

These fellowships shall be open to any graduate of the School of Practical Science and of the Faculty of Applied Science and Engineering of the University of Toronto; also to anyone who has attended a regular course for two years in this Faculty and subsequently by following his profession has attained a position of importance in his field of work.

Each fellow shall devote at least 26 weeks' work to his research.

It is intended that the Research Work during the life of the fellowship shall be conducted in the laboratories of the Faculty of Applied Science and Engineering, University of Toronto, and under the supervision and guidance of the professor at the head of the department involved.

On the completion of his work under this fellowship, the holder shall make a written report to the executive committee of the Engineering Alumni Association outlining the course of his Research Work and the results obtained; provided, however, that if on representation to the Executive Committee, it shall be deemed advisable to withhold such information for a time, permission so to do may be granted.

Since the inauguration of the Research Fellowship, the fellowships have been awarded to: M. R. Shaw, 1909, Chemistry, awarded in 1912, and W. P. Dobson, 1910, Investigation of Disturbances in High Tension Transmission Systems, awarded in 1912, renewed for two additional terms. Owing to the lack of space, we are unable to publish the results of these scholarships, but suffice it to say that the executive feels that they have been amply repaid for the effort which they put forth in securing sufficient funds to carry on this work.

We also wish to take this opportunity of thanking the graduates who subscribed to this worthy object. It is unfortunate that, owing to the present conditions, we will not be able to carry on this valuable work, but we live in anticipation of increased activities after the restoration of normal conditions. In the interim, we hope that the graduates will not forget and will be ready to contribute when called upon

During this year, the Toronto Executive Committee are endeavoring to affect a reorganization of the whole of the association so that branches will work in harmony with and through the organization located in Toronto. A new set of by-laws is being prepared and they will be submitted to the different branches for discussion. If we are successful in this venture we feel that a great deal will have been accomplished, and the bright future of the organization will be ensured.

"W. R. Worthington,"
President, Toronto Branch.

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## OTTAWA ALUMNI ASSOCIATION

For many years Ottawa "School" men have felt that there should be some recognized relationship between the Faculty of the "School" and the graduate body, and also between the graduates themselves resident in various centres. We have felt that there is a great work to do in Ottawa for the "School" in advancing the interests of "School" men in the various departments of the Government service, in assisting and advising the recent graduates regarding opportunities in the Government service, and in helping undergraduates to find suitable employment during the summer vacation.

A few years ago, a few graduates of the "School" resident in Toronto organized what was known as the Engineering Alumni Association of the University of Toronto. A constitution and by-laws were adopted which would indicate that the Association was intended to comprise all graduates of the "School." This Association has done good work in the interests of the "School," and has, for instance, conceived and carried out a scheme of research from which it is understood excellent results have been obtained.

Quite independent of this Association, "School" organizations in various centres have been formed without any reference whatever to it. For instance, Ottawa "School" men have formed the Ottawa Branch of the Engineering Alumni Association of the University of Toronto. A constitution and by-laws have been adopted which take no cognizance of the original Association in Toronto.

The present situation, therefore, is that there are "School" organizations of various descriptions in Toronto, Ottawa, Montreal, Pittsburgh, Winnipeg, Calgary, Vancouver, which are not correlated in any way. In union there is strength, and the Ottawa "School" men feel that the graduates of the "School" will never be able to make their influence felt for the best interests of the old "School" until the various "School" alumni organizations are properly correlated.

In my opinion this correlation can be best realized by having branches of the University of Toronto Engineering Alumni Association formed throughout the various centres. Provision should be made for the relationship of these branches with the Toronto organization and with one another. Just what relationship this should be may be somewhat difficult at the present stage to work out, but a satisfactory solution can no doubt be had if the problem is given any thought or consideration. In so far as Ottawa "School" men are concerned, there need be no doubt about their heartiest co-operation and active assistance in any movement that will advance the interests of the old "School," its Faculty, its graduates and its undergraduates.

"J. B. Challies,"
Secretary, Engineering Alumni Association,
Ottawa Branch.

## SCHOOL WELL REPRESENTED IN INTER-COLLEGE DEBATING

The second year of School's entry into the Inter-College Debating Union showed a great improvement over last year. This year we defeated Knox College, in the first round. Mr. L. R. Shoebottom, '17, and Mr. V. S. C. McClenaghan, '18, were the successful debaters.

In the next round we drew against Wycliffe College and were defeated by a narrow margin. The judges giving the decision stated that while the School debaters were better on matter they lost on style. This goes to show the necessity of a course of public speaking in this institution before our men can hope to cope on equal terms with men from other colleges where such a course is in force. Not only for debating would such a course be a decided benefit for School men, but it is now recognized that a successful engineer, no matter in what branch he specializes, is under a great handicap if he has not the ability to speak on his feet.

Mr. H. L. McClelland, '16, and Mr. V. S. C. McClenaghan, '18, represented the School in the second debate. Wycliffe College finally won the Kerr Shield, the debating trophy of the I.C.D.U.

Mr. W. B. Honeywell, '17, was the School representative on the Inter-College Debating Union and was elected vice-president.

## ATHLETICS

Following the precedent established in 1914-15, no teams represented the university against outside teams last year, attention being confined to the inter-faculty contests. In rugby, Junior School won the Mulock Cup from Victoria, but lost at soccer. Both junior and senior teams won their respective groups in hockey, but each lost out to the two Dental teams in the semi-finals. The sophomores defeated the freshmen in their annual fall struggle, and our track team captured third place at the inter-faculty field day sports. On another page is shown Hart House, the new students' building, as it appeared on June 22. It is expected that the building will be opened next winter.

## A PSALM OF LIFE AT S. P. S.

A. T. C. McMaster, '01

[Few of us know the history of our Psalm of Life, or the original wording of it. Prof. Price tells us that Mr. McMaster of his year was the one whose poetic skill created it. Mr. McMaster, who is now an engineer and contractor in Toronto, has consented to give us the story.—Editor].

### The Original Words

1. Stand up! Stand up for the Science Faculty!
With the Arts and the Meds they form a trinity.
Then shout you chaps for the S.P.S.,
Whose motto is meekness and peacefulness.

2. The first-year man when he comes up to the School
Gazes with awe on a two-foot rule.
Then shout——

3. The second-year man has learned about the tap;
He sizes up the freshman with an eye to a scrap.
Then shout——

4. The third-year man'd rather fall down a mine
Than go to the depths of Constructive Design.
Then shout——

5. The fourth-year man comes back to have a fling;
He bums round the lab and he "doesn't do a thing."
Then shout——

6. Now we hope this song has touched your hearts,
And you won't consign us to warmer parts.
For we've shouted this psalm for the S.P.S.,
Whose motto is meekness and peacefulness.

This is the song we sang when welcoming the then Duke of York, our present King George V, to old Varsity. I am informed that the blame for it has been laid upon my shoulders. I must admit some of it, but will tell you the whole story and let you judge for yourselves.

The Convocation at which the Duke received his honorary degree, as he passed through Toronto on his grand tour of the British Empire in 1901-02, was held in the East Hall of the main building. The ground floor was reserved for the invited guests, and the small gallery was given over to the students. This necessitated the choice of just two or three representative members of each class. Among those chosen from S. P. S. was the writer, then in his fourth year.

In order that things might run smoothly, it was decided to have some rehearsals of college yells and songs in one of the class rooms of the main building. It then transpired that all the faculties and affiliated colleges, but S.P.S., had special songs of their own. Whereupon one of the professors present, recognizing in me one who formerly had followed him along arduous trails in ancient literature, turned his sarcastic rhetoric on me and questioned why the School had never been able to produce or even adopt anything worth singing. Now in those days criticism from any outsider was strenuously resented, for, when not busy with lectures or drafting or lab work, we were working off our pent-up energies in winning all interfaculty cups, or turning things inside out with our famous scraps. The result of that criticism, therefore, was to get my Irish up, and D. L. H. Forbes[1] and M. V. Sauer[2] and I spent the evening doping out the Psalm of Life at S.P.S. to the then popular air of "The Dutch Companee."

The next morning I submitted the Psalm to our Dean (the late Dean Galbraith) to make sure that he had no objection to any of the sentiments expressed, had it typewritten, and placed in the hands of the vocal committee so that when the next rehearsal took place, either that afternoon or the following one, there was no longer any cause to be ashamed of a faculty unhymned and unsung.

It has been a surprise to me to find such a hasty effort still clinging to the old School. I believe the real cause has lain in the deep irony of that last line of the refrain:—"Whose motto is meekness and peacefulness." I well remember the glee with which Max Sauer and I greeted this masterpiece when suggested by Dave Forbes. And possibly His Royal Highness, all unconscious of its irony, may have been comparing this sentiment with some of the truculent utterances of the War Lord against whose mailed fist so many of our School men are now opposing their best efforts of body and mind.

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[1] Chief Construction Engineer, Chile Exploration Co., Chuquicamata, Chile, South America.
[2] With the Greater Winnipeg Water District.

## HOW CANADIANS JOIN THE AVIATION CORPS

Canadian applicants for aviation training have but the British service to consider as, so far, the Canadian Government has not seen fit to establish an Aviation Corps, distinctively Canadian.

The British Air Service is divided into two sections, the Royal Naval Air Service and the Military Wing of the Royal Flying Corps. For both of these services there is a very rigid examination for physical condition and an even more rigid one in regard to the eye sight. An aviator must have eye sight of the very highest to enable him to distinguish objects at a long distance and to easily and quickly determine the color of the various objects which he may see during his flights.

The question of age also enters into consideration for both branches of the service. For the Navy, applicants must be from 19 to 25 years of age and for the Army up to 30 years. The Navy is, perhaps, more rigid as to the question of age, as they ask for a copy of the birth certificate of the applicant. Applications are made to Admiral Kingsmill of the Department of the Naval Service at Ottawa and in every case the applicant has to meet him personally, in addition to the production of a number of certificates of good character, etc.

The applicant having passed these, he must needs qualify for his pilot's certificate and the majority of them have done so at the aviation school operated by Curtiss Aeroplanes & Motors, Limited, which is situated at the Rifle Ranges at Long Branch. The cost of such course is four hundred dollars, but of this $375 is refunded by the British Government upon the aviator successfully passing the further tests that are imposed in England, namely, cross country flying. This year the Canadian Government is making a grant of one hundred dollars for maintenance to each candidate who successfully gets his pilot's certificate.

The course of instruction in flying is simply the handling of a machine. The first trip is usually a "joy ride" to give the candidate some idea of what the machine can do and get him accustomed to its operation. In succeeding flights the candidate is gradually given control of the machine. These machines are equipped with dual control so that this can easily be accomplished, the instructor being ready at any time to check any error made by the pupil. Gradually the pupil becomes proficient in handling the machine in the air. Then there follows a more tedious section of the instruction, that of enabling him to properly take the machine off the land and bring it down safely without the destruction of the machine. This is the hardest part of the instruction, because the pupil has to learn to judge the distance and speed of the machine.

After a course of five or six weeks of instruction the day of testing arrives and under the oversight of some representative of the Royal Aero Club of Great Britain the candidate will take the machine out alone and be called upon to make two series of figure eights, from one of which he is to make a landing within a certain distance of a prearranged mark. The final test is to ascend to a height of about 500 feet, then cut off his motor, glide down, landing within a certain distance of a mark. Having accomplished this successfully a report is made at once to the Royal Aero Club and the candidate is entitled to receive his certificate, which he has to obtain personally in England.

Immediately following the successful tests the information is forwarded to Ottawa and the candidate is practically under orders and is sent to England within a week or ten days.

On reporting there the additional training is at once taken up. This includes a series of lectures on aeroplane and motor construction, wireless, signalling of all kinds, machine gun work and bomb dropping. Further, the pupil has to become proficient in handling a certain number of other makes of machines. He is also called upon to do cross country flying to a distance of from 40 to 60 miles, make a report upon what he has seen, and draw a map of the district over which he flew. When he has done this successfully, he obtains his "ticket" and becomes a full fledged pilot, either military or naval, and is entitled to the wings, the badge which shows his proficiency. He then may be sent out as an instructor at one of the schools or may go into active service.

Among the many who have gone through the Curtiss school and are now in England or France are the following School men: D. G. Joy, G. A. Gooderham, C. N. Geale, G. R. S. Fleming, G. K. Williams, R. D. Delemere, C. G. Hewson, J. Robinson, E. R. Grange, K. Waugh, A. G. Knight, G. G. MacLennan, W. R. Da Costa, F. C. Birtle, G. S. Gray, R. H. James, N. C. Millman, R. E. A. Macbeth, H. A. Wood, W. M. Carlyle.

## "OUR RESPONSE TO THE EMPIRE'S CALL"

Ever since war was declared, there has been a steady stream of School men answering the call of King and Country. They are to be found in almost every unit and arm which Canada has contributed or is contributing to the cause. The graduates from coast to coast have flocked to the flag.

Many graduates, as well as under-graduates, were in the first Canadian Contingent; more were in the second, while a host of others are enlisting and getting ready.

To-day we honour the names of the following nine of our number who have given their lives for us and our country: **Andrews, F. C.,** '14; **Eardley-Wilmot, F. L.,** '17; **Helliwell, J. G.,** '10;

**Hughes, C.**, '09; **Klotz, H. N.**, '09; **Lawless, N.**, '11; **Revell, G. E.**, '99; **Taylor, G. B.**, '14; **Ryerson, G. C.**, '05.

Many have received well merited promotion, others have received special mention in order, while not a few have won military honours. The Chief Intelligence Officer of the First Contingent was Major C. H. Mitchell, '92, of the Corps of Guides, now Lieut.-Colonel on the General Headquarters Staff of the Canadian Army Corps in France. His work has been mentioned many times in despatches, for which he has been awarded the D.S.O., by the King and La Legion d' Honneur Croix d' Officier by the President of the French Republic. The Intelligence Officer of the Second Contingent was again a School man, Major J. L. R. Parsons, '01. Like the first contingent, this too contained many School men in every capacity, as may readily be seen in the published list, which follows.

In many of the units, "School" men have been of recognized service on account of their special training and experience, such as mechanical men in the transports, the electrical in the Signalling Corps, the civil, mining and architectural in the Engineers, etc. Aviation has offered alluring inducements to many, for while McCurdy, '07, Riddell, '04, and others, are busy building machines in Toronto, G. K. Williams, '10, is mechanical superintendent of the Air Training School at Detling in Kent. A reference to the list will show many others connected with this service. School men have thus contributed largely to this, the newest arm of the service.

The Second Field Company of Canadian Engineers were asked to supply a Field Company of War Strength (217) for the First Contingent and in short order Captain T. C. Irving, '06, was on his way to Valcartier with his company fully recruited to strength. With him he took many School men, as officers, non-commissioned officers and sappers. When they sailed for England Irving was second in command. Before reaching France, however (on account of the illness of the major) he was given command of the company. Very shortly afterwards in recognition of his excellent work, he was made major. The good work this company of engineers has done and is doing along the firing line of the Canadian Battle Front in France, is evident from the official despatches of both London and Paris, as well as by the many awards of merit from Britain and France.

Lieutenant now Captain H. F. H. Hertzberg, '07, was rewarded for his brilliant work, with the Military Cross. Sergeant C. B. Ferris received the D.C.M. and the Croix de Guerre.

Sapper now Lieutenant C. P. Cotton, '15, has been awarded the Russian Cross of St. George; and Sergeant W. H. B. Bevan, '05, was also awarded the D.C.M. The official report, as published in the Toronto press, contains the following:

"SERGEANT C. B. FERRIS, Second Engineers, for advancing alone under extremely heavy fire and making a valuable report, after being shot in the lungs."

"SERGEANT W. H. B. BEVAN, Second Engineers, checked the native troops retiring in disorder and inspired all ranks with his fine example."

While the Second Field Company of Engineers was in England, Corporal M. B. Watson, '10, met with an accident (rolled down an embankment with a motor truck) and as a result was in the hospital when they moved over to France. Later on, however, he was given a commission in the Royal Engineers and ever since has been acting as a lieutenant with an Army Corps Troop in France. His visit (on leave) to the Engineering Society, a short time ago, was a treat, and all who were fortunate enough to hear him will remember the occasion, as one of the features in this college year.

The Machine Gun Section of many of the Canadian Battalions, the Eaton Machine Gun Battery, as well as a large number of the batteries of artillery, contained School men in different capacities.

To-day the attendance at the Old School is so greatly reduced that if the roll were called at a muster parade, not more than two hundred would answer to their names. The ranks of the staff are likewise thinner, as the call keeps up, for they, too, are "doing their bit." Many of those left are doing extra duties, in order to let their confreres off for military service. Professor McConnell, is now captain and adjutant of the 116th Battalion, C.E.F.; Professor Cockburn with the rank of captain, has command of "A" company in the 170th Battalion; Mr. J. S. Galbraith, is assistant adjutant of the 123rd Battalion; Mr. H. O. Merriman, with the rank of flight lieutenant, is with the Royal Naval Air Squadron; Mr. G. H. Hally is a gunner with the 26th Battery, and Mr. A. L. Steele is with the Canadian Army Service Corps.

Professor C. R. Young and Mr. H. H. Madill, are on the Cadre of the School of Instruction for Number 2 Division, while Professor T. R. Loudon has charge of the Instruction in Engineering to the C.E.F.'s Battalions for Number 2 Division. Major A. D. LePan is adjutant with the School of Instruction in the same division.

It is safe to say that there will be a great representation from the Faculty of Applied Science in the University Overseas units, just authorized, viz., the University of Toronto Officers' Training Company and the University of Toronto Battery of Artillery.

At the recent Garrison Artillery examination held in England, two School men, E. B. Allan, '16, and R. T. C. Hoidge, '16, stood first and second respectively in the examination for second lieutenants.

The following list of School men on active service is as complete as the Engineering Society has been able to compile and any corrections or additions will be welcomed.

That so many of the undergraduates of last session and this have been able to acquit themselves so efficiently, is largely due to the enthusiastic manner in which they have availed themselves of the opportunities offered by the University of Toronto Contingent of the Canadian Officers' Training Corps, which was established shortly after the outbreak of hostilities, by the Honourable Sir Sam Hughes, Minister of Militia, at the request of President Falconer.

# ON ACTIVE SERVICE

† Killed in action. ‡ Wounded. ° Prisoner of war. * Honors.

Abendana, E. M., Lieut., '14; Canadian Engineers.
Adlard, L. S., Lieut., '15; Camp Lab. Unit, 2nd Div.
Affleck, J. K., '18; 67th O.S. Bty., C.F.A.
Affleck, R. D., '18; 67th O.S. Bty., C.F.A.
Aggett, W. H., Gnr., '17; 25th Bty, C.F.A.
Allen, Carl W., Capt., '01; 2nd Canadian Pioneers Bn.
Allan, E. B., 2nd Lieut., '16; Imperial Army.
Allan, F. R., Pte., '18; 35th Bn., Mach. Gun Sec.
Allan, L. B., '11, Course at S.O.I.
‡Alport, F., Lieut., '06; 6th Field Co., C.E.
Amsden, W. G., Lieut., '10; 220th Bn.
Anderson, A. S., Pte., '13; 2nd University Co., P.P.C.L.I.
Anderson, C. C., Sapper, '16; No. 3 Stationary Hospital.
Anderson, F. J., Lieut., '07; 98th Bn.
Anderson, A. C., '15; 2nd Univ. Co., P.P.C.L.I.
Anderson, R. M., Lieut., '08; Div. Cyclist Depot.
†Andrews, F. C., Lieut., '14; Imperial Army.
Andrew, W. B., Lieut., '17; 33rd Bn.
Angus, J. C., Sapper, '18; Divisional Signal Co.
Archer, E. G., Lieut., '11; Course at Kingston.
Armstrong, T. E., Driver, '16; 21st Bty., 6th Howitzer Bde.
Armstrong, W. D., Sapper, '17; 6th Field Co., C.E.
Arthur, R. M., Gnr., '15; 25th Bty., C.F.A.
Austin, F. D., L.-Cpl., '15; 2nd Signal Co., R. C. Engineers.
Avery, C. R., Gnr., '13; 4th Bde., 13th Bty.
Aykroyd, G. C., Pte., '18; 40th Bty., C.F.A.

Baird, W. J., Cpl., '10; Divisional Train, C.A.S.C.
Baldwin, F. W., Lieut., '06; Royal Flying Corps.
Baldwin, L. C. M., Lieut., '13; 9th South Lancashire Regt.
Ball, O. V., Gnr., '17; 47th Bty.
Barbour, R. A., Lieut., '17; C.A.S.C.
Barnes, L. F., Lieut., '16; Imperial Army.
Bartlet, F. A., '15; 1st Contingent.
Bauer, W. R., Gnr., '17; 25th Bty., C.F.A.
Beacock, V. A., Pte., '15; 3rd University Co., P.P.C.L.I.
Beatty, F. W., Gnr., '13; 43rd Bty.
‡Bell, C. A., Lieut., '13; 2nd Field Co.
Bemrose, B. W., '16; 67th O.S. Bty., C.F.A.
Bennett, S. G., 2nd-Lieut., '14; Royal Engineers.
Berkeley, G. L., Capt., '11; Div'l Cycle Corps, O.C.
Betts, H. H., Lieut., '06; Ry. Transport, Boulogne.
Bevan, T. H. H., Lieut., '08; M. G. Sec., 86th Bn.
*Bevan, W. H. B., Cpl., '05; 2nd Field Co. (won D.C.M.)
Binns, P. V., Lieut., '14; 2nd Fd. Co., Canadian Engineers.
Binns, R. E., Lieut., '13; Royal Engineers.
Birchard, E. R., Sgt.-Major, '09; Eaton Bty.

Bishop, C. A., Lieut., '18; 220th Bn.
Bishop, W. A., Gnr., '17; 25th Bty, C.F.A.
Black, A. P., Pte., '15; St. John's Ambulance Hosp.
Blackstock, G. G., Lieut., '15; Imperial Army, General Burstall's Staff.
Blair, F. J., Lieut., '11; 198th Bn.
Booz, F. B., Pte., '18; 34th Bty.
Breen, J. M., Sapper, '18; Divisional Signal Co.
Breithaupt, J. E., '15; Course at S. of I.
Brereton, L. R., Sgt., '13; 2nd Troop Co., Can. Engrs.
Brock, W. M., Sapper, '11; Div'l Signal Co., C.E.
Brodie, W. M., Lieut., '95; Course at S. of I.
Brouse, E. D. G., Lieut., '15; C.A.S.C.
Brown, W. G., 2nd-Cpl., '16; 5th Field Co., C.E.
Bryant, G. F., Lieut., '18; Imperial Army.
Burden, H. J., Capt., '15; 75th Bn.
Burgess, J. R., '10; Canadian Engineers.
Burn, G. A. H., Pte., '17; Divisional Signal Co.
Burness, K. C., L-Cpl., '15; 2nd University Co., P.P.C.L.I.
Burton, C. E., '17; 67th O.S. Bty., C.F.A.
Burton, H. R., '18; Divisional Signal Co.
Burwash, N. A., Sapper, '03; 6th Fd. Co. C.E.
Bush, C. E., Lieut., '07; Div'l Cycle Corps.
Bussell, E. I., Lieut., '19; Course at P.S.I.
Byres, E. S., Gnr., '17; 25th Bty.

Cameron, O. L., Lieut., '13; 12th Rgt.
Campbell, F. W., Pte., '18; R.C.H.A.
Campbell, H. M., Lieut., '14; Spec. Service Squad, 1st Hussars. 2 C.E.F.
‡Campbell, P. G. C., Lieut., '15; R.F.C.
Campbell, J. J., Lieut., '14.
Campbell, J. J., '14; 67th O.S. Bty., C.F.A.
‡Campbell, W. C., Lieut., '05.
Canniff, C. M., Pte., '88; 74th Bn.
Carlyle, W. M., Lieut., '10 Royal Naval Flying Corps.
Carmichael, A. H., Lieut., '18; 180th Bn.
Carscallen, H. R., Lieut., '08; Canadian Engineers.
Carruthers, K. L., Lieut., '19; Imperial Army.
Carter, J. M., Gnr., '14; 34th Bty.
Catto, R. W., Lieut., '15; Royal Flying Corps.
Caudwell, N. S., Lieut., '10.
Cavers, J. P., Sgt., '16; Machine Gun Section, C.E.F.
Cawley, H. E., Lieut., '09; 7th Bty., 3rd Bde.
Chamberlain, K. H., Sgt., '18; H. Q. Base Staff.
Chambers, E. V., Lieut., '14; 92nd Bn., Machine Gun Section.
Chantler, H. M., Pte., '19; Div'l Cycle Corps.
Chapman, J. R., Gnr., '16; 49th Bty.
Chavignaud, L. G., '15; 19th Bn.
Cheney, S. K., Gnr., '16; 25th Bty., 7th Bde.
Chesnut, A. W., Pte., '10; 4th Univ. Co., P.P.C.L.I.

‡Chesnut, E. F., Cpl., '11; 19th Bn., No. 1 Co.
Clarke, F. F., Lt.-Col., '03; 127th Bn. O.C.
Clark, H. S., Lieut., '10; 36th Bn.
Clarkson, G. E., Lieut., '13; 123rd Bn.
Coatsworth, C. P., Lieut., '18; Pioneers Bn.
Cockburn, G. A., Lieut., '15; 43rd How. Bty., C.F.A.
Cockburn, J. R., Capt., '01; 170th Bn.
Cockburn, R. M., Lieut., '15; 116th Bn.
‡Code, A. G., Sapper, '10; Div. Engineers, 1st C.E.F.
Connor, R. A., Lieut., '18; Imperial Army.
Cooch, H. A., Q.M., '09; 216th Bn.
°Cory, R. Y., Capt., '08; 15th Bn.
*Cotton, C. P., Lieut., '15; 2nd Bde., C.F.A. (Cross of St. George)
Coulthard, R. W., Major, '99; No. 2 Tunnelling Corps.
Craig, J. H., Capt., '10; Adj. 127th Bn.
Craigie, D. E., Sapper, '18; Div'l Signal Co.
Crane, J. W., Lieut., '18; 216th Bn.
Crawford, A. W., Cpl., '14; Signal Co., C.E.
Cross, R. A., Pte., '17; 2nd Univ. Co., P.P.C.L.I.
Crowell, C. R., Lieut., '19; Imperial Army.
Crysler, R. A., Gnr., '17; 47th Bty.
Curtis, W. T., Lieut., '13; 2nd Canadian Pioneers Bn.
Crowe, H. L., '19; Royal Flying Corps.

Dalton, George F., Lieut., '14; Canadian Engineers.
Dingnam, H. M., '19; 67th O.S. Bty., C.F.A.
Dale, W. P., Sapper, '17; Divisional Signal Co.
DaCosta, W. R., Lieut., '15; Royal Flying Corps.
Dafoe, E. R., Gnr., '17; 25th Bty., C.F.A.
‡Daniel, N. H., Lieut., '15; Artillery.
Daniel, T. A., '16; 26th Bty., C.F.A.
‡Dashwood, G. R., '16; 13 Northumberland Fusiliers.
Dashwood, R., Lieut., '14; 13 Northumberland Fusiliers.
Davidson, G. P., Lieut., '15; Imperial Army.
Deacon, L. J., '18; Army Transport.
Dean, W. A., Lieut., '15; 198th Bn.
DeGruchy, P. C., '17; Field Ambulance.
Delamere, R. D., Lieut., '14; Royal Flying Corps.
Delaporte, A. V., Capt., '10; Hyd. Corps.
Devlin, H. K., Lieut., '18; 75th Bn.
Dickenson, M. E., Pte., '18; Div'l Ammunition Sub-Park.
Dobbin, W. L., Lieut., '16; Canadian Engineers.
Downey, G. A., Lieut., '15; 12th Bty., C.F.A.
Downie, R. W., , Sgt., '16; 2nd Field Co., C.E.
Downing, F. H., '11.
Drybrough, J., Pte., '19; 67th O.S. Bty., U. of T.
Duncan, J. M., Lieut., '10; H.M.S. Lion, R.N.
Durbrow, P. A., Gnr., '17; 26th Bty., C.F.A.
Dustan, E. B., Gnr., '17; 25th Bty., C.F.A.
Duggan, S. F., '18.

Eadie, L. F., L.-Cpl., '10; 75th Bn.
†Eardley-Wilmot, F. L., Lieut., '17; P.P.C.L.I.
Eastwood, J. H., Lieut., '16; 93rd Bn.
Eby, H., Pte., '17; 47th Bty., C.F.A.
Edmonds, C. W., Gnr., '16; 25th Bty., C.F.A.
Elliott, G. R., Lieut., '11; Div'l Cyclist Corps.
*†Ellis, S. D., Lieut., '14; Imperial Army (died after operation for appendicitis). (Awarded M.C.).
Evans, A. C., '15.

Farrelly, T. J., Sapper, '11; Div'l Signal Co.
Fasken, J. E., '18; 67th O.S. Bty., C.F.A.
Ferguson, D. G., Lieut., '14; 123rd Bn.
Ferguson, G. H., Capt., '05; Canadian Engineers.
‡**Ferris, C. B., Sgt., '13; 2nd Field Co., C.E. (D.C.M.; Croix de Guerre).
Firstbrook, J. H., Lieut., '18; Royal Flying Corp, (Naval Wing).
Fleming, G. O., Lieut., '14; 1st Construction Bn.
Fleming, G. R. S., Sub-Lieut., '07; Royal NavalAir Service.
†Fleming, J. S., Sgt., '14; 2nd Canadian Pioneers Bn.
Flint, C., Lieut., '08; C.P. Ry. Construction Corps.
Fowlds, E. S., Sapper, '13; 2nd Field Co.
Fraser, R. A., Lieut., '16; 37th Bn.
French, W. G., '15; Ry. Construction Corps.
Frid, H. P., '15; 86th M.G. Bn.
†Frogley, H. W., Corp., '11; 5th Field Co.
Fuller, C. H. R., Lieut., '14; 216 Bn.

Gage, C. E., Sgt., '16; Ammunition Column, 4th Bde.
Galbraith, J. S., Capt., '13; 123rd Bn., Asst. Adj.
Galbraith, R. D., Lieut., '15; 23rd Reserve Bn., C.E.F.
Gall, Hugh, Lieut., '10; 2nd Fd. Coy, Canadian Engineers.
Gardner, J. W., Lieut., '18; 177th Bn.
Gardner, R. T., L.-Cpl., '19; 53rd Bty.
Gardner, D. B., Lieut., '16; Canadian Engineers.
Garrow, A. B., Lieut., '07; 74th Bn.
Garvie, J. A., Lieut., '18; Imperial Army.
Geale, C. N., Flight Sub-Lieut., '15; Royal Naval Air Service.
Gemmell, K. S., Sapper, '18; Div'l Signal Corps.
German, D., '17; 4th Bde. Hdqts., C.F.A.
Gibson, F. R., Lieut., '17; Mechanical Transport.
Gibson, J. M., Capt., '10; 127th Bn.
Gilley, J. R., Lieut., '17; 234th Bn.
Gilley, E. R., Sapper, '17; Divisional Signal Co.
Gill, E. I., Lieut., '14; Course at Kingston.
Gillies, A., Lieut., '07; 186th Bn.
Givens, H. F., Lieut., '19; Imperial Army.
Glass, L. G., Sapper, '15; 4th Div'l Signal Co.
Glover, T. S., 2nd-Lieut., '17; 3rd Bn. King's Own Yorkshire Light Infantry.
Gooderham, G. A., Lieut., '15; R.F.C. (Naval Wing).

Gooderham, H. S., Lieut., '18; 20th Bn.
Gordon, R. V., '18; 88th Bn.
Gorrie, H. T., Lieut., '18; C.A.S.C.
Gouinlock, G. R., '18; Course at Kingston.
Gouinlock, R. W., Lieut., '14; 123rd Bn.
Graham, D. S., Lieut., '17; Div'l Cycle Corps.
Graham, T. S., Sapper, '15; Div. Signal Co.
Grange, E. R., Lieut., '15; R. F. C.
Grassett, H. A. M., Pte., '16; 3rd Bn.
Gray, A. G., Lieut., '13; 44th Reg.
‡Gray, A. J., Lieut., '13; 16th Bn.
Gray, G. S., Lieut., '15; Royal Flying Corps.
°Greene, E. A., Lieut., '11; 9th Bty., 3rd Bde.
°Greene, G. E. D., Lieut., '09; 3rd Bn.
Greene, P. W., Lieut., '06; 35th Bn.
Greey, Allan, Lieut., '09; 170th Bn.
Gzowski, J. S., Lieut., '09; 19th Bn.

Haas, M. S., Lieut., '15; 36th Bn.
Hadley, W. F., '16; No. 1 Div. Corp of Guides.
†Hagarty, D. G., Lieut., '16; 2nd Univ. Co., P.P.C.L.I.
Hague, R. D., Sapper, '08; No. 3 Co., Div'l Engineers.
Haldenby, E. W., Lieut., '17; 92nd Bn.
Hally, G. H., Gnr., '14; 26th Bty., C.F.A.
Hames, C. O. R., Sapper, '19; Div'l Signal Co.
Hanna, J. J., Sapper, '14; 1st Field Co., C.E.
Harcourt, R. M., Capt., '09; 35th Bn.
Harman, J. A., Sub-Ft. Lieut., '11; Royal Flying Corps.
‡Harris, R. W., 2nd Lieut., '15; R. E.
Harrison, R., Sapper, '18; Divisional Signal Co.
Harron, L. W., Lieut., '16; 204th Bn. (Signalling Officer).
Harrop, C. E., '17; 67th O.S. Bty., C.F.A.
Harvie, N. J., '10.
Hastings, C. E., Lieut., '16; C.A.S.C.
Hastings, M. B., '11; Course at Kingston.
Hawkey, R. R., Gnr., '17; 47th Bty.
Hayman, L. T., Lieut., '14; Course at P.S.I.
Heatley, A. H., Pte., '19; 5th Univ. Co. P.P.C.L.I.
*‡Heaton, H. A., Lieut., '15; Royal Lans. Regt. (Won M.C.).
†Helliwell, J. G., Capt., '10; 1st Bn.
Henderson, M. G., Gnr., '17; 47th Bty, C.F.A.
Henderson, T. D., Lieut., '04; Canadian Engineers.
Heron, J. B., Lieut., '04; 1st Const. Batt.
*‡Hertzberg, H. F. H., Capt., '07; 2nd Field Co., 3rd Bde. (Won M.C.)
Hewson, C. G., 2nd-Lieut., '17; Royal Flying Corps.
Hewson, R. R., Lieut., '15; Ry. Constr. Corps.
Hill, Gnr., 43rd Bty.
Hinch, E. F., '11; C.F.A.
Hoag, C. K., '17; Sig. Sec., 4th C.M.R.
Hoidge, R. T. C., 2nd-Lieut., '16; Imperial Army, R.G.A.

Holcroft, H. S., '00; No. 2 Tunnelling Co., Calgary.
Hopkins, C. H., Sapper, '09; 5th Field Co., C.E.
Hopkins, H. R., '16; Ammunition Column.
‡Hopkins, R. H., Lieut., '06; 39th Bn. (wounded in motor car accident).
Houston, F. C. A., Act.-Sgt.-Major, '19; 201st Bn.
Howes, E. A., Pte., '17; 41st Bty.
Howlett, T. F., '13; 2nd Contingent.
Hughes, B. H., Sapper, '14; 6th Field Co., C.E.
†Hughes, Chester, Lieut., '09; 6th Field Co., C.E.
Hughes, C. A., Gnr., '17; 47th Bty.
Hume, A. G., '18; U. of T. O.S. Training Co., C.O.T.C., C.E.F.
Hunter, W. H., Lieut., '17; Course at P.S.I.
Husband, L., Lieut., '16; 76th Bn.
Hutchings; W., '14; 34th Bty.
Hutcheson, F. W., Lieut., '13; Canadian Engineers.
Hall, W. T., '15; Royal Flying Corps.

Ingersoll, L. H., Sub-Flight-Lieut., '17; Royal Flying Corps.
Ingles, C. J., Major, '04; 176th Bn.
Irving, T. C., Major, '06; 2nd Field Co., Canadian Engineers.
Irwin, H., Lieut., '09; 14th Bty.
Ives, V. E., Pte., '17; No. 4 General Hospital.

Jackson, K. B., Pte., '16; 49th Bty., C.F.A.
Jack, T. B., '18; Imperial Army Service Corps.
Jarvis, R. H., Lieut., '11; Royal Naval Air Service.
Johnston, E. W., Gnr., '17; 54th Bty.
Johnson, S. H., Lieut., '18; .
Jones, L. E., Capt., '11; 2nd Bn.
†Jones, Trafford, Lieut., '06; Royal Flying Corps.
Jones, R. E., '14; C.A.S.C.
Junkin, R. L., Lieut., '13; 5th Field Co., C.E.
Jupp, E. H., Gnr., '15; 40th Bty.

Kay, J., Lieut., '14; 15th Bn.
Kayler, K. D., Sapper, '18; Divisional Signal Co.
Keefer, N. G., Lieut., '14; Imperial Army.
Keith, D. F., Major, '07; 75th Bn.
‡Kerby, H. S., Lieut., '14; Royal Flying Corps, No. 3 Squadron.
Killip, Lieut., '08; 86th Bn.
Kilmer, C. E., Lieut., '13; 19th Bn.
Kirby, R. W., Bom., '16; 53rd Bty., C.F.A.
Klinger, L. W., Lt., '07; 2nd Field Co., C.E.
†Klotz, H. N., Lieut., '09; 2nd Bn.
Knight, A. G., Lieut., '17; Royal Flying Corps (Army Branch).
Knight, J. A., Cpl., '14; 3rd Divisional Cycle Corps.
Krug, S. J., Pte., '16; Mechanical Transport, C.A.S.C.

Laing, P. A., Pte., '05; 2nd Univ. Co. P.P.C.L.I.
Langford, J. A., Lieut., '18; Divisional Signal Corps.

Latornell, A. J., Lieut., '03; 14th Bty.
†Lawless, N., Driver, '11; 5th Bn., 2nd Bde. (died of fever).
Lawrence, G. W., Lieut., '15; 81st Bn., Sig. Officer.
Lee, L. A. C., Lieut., '16; Divisional Signal Corps, C.E.
Legate, J. H., Gnr., '17; 25th Bty, C. F. A.
LePan, A. D., Major, '07; Headquarters Staff.
Leslie, A., Lieut., '13; Course at Kingston R. So. of Art.
Little, H. B., Lieut., '16; B. Reserve Bde., R.H.A.
Livingstone, A. H., '18; 5th Univ. Co., P.P.C.L.I.
Lloyd, E. G., '18; 34th Bty, C.F.A.
Lockhart, W. E., Sapper, '15; 2nd Signal Co., R.C. Engineers.
Lorimer, N. H., '14; C.F.A.
Loudon, T. R., Lieut., '05; 1st Construction O.S. Bn.
Lowrie, A. W. P., '11; 82nd Bn.
‡Lye, O. G., Cpl., '14; 2nd Univ. Co., P.P.C.L.I.

MacBeth, R. E. A., Lieut., '11; Royal Flying Corps (Army Branch).
Macaulay, G. B., '14; 1st Contingent.
Macaulay, R. V., Bom., '11; 2nd Bde., 5th Bty.
McClelland, J. P., Pte., '18; Ammunition Sub-Park, 2nd Div., C.E.F.
McClenaghan, V. S. C., Pte., '18; Canadian Engineers.
McClintock, G. A., Bom., '17; 2nd Bde., C.F.A.
McColl, J. R., Lieut., '16; 124th Bn.
McConnell, A. W., Capt., '06; Adj. 116th Bn.
McCort, C. R., Lieut., '15; No. 6 O.S. (McGill) Bty., Siege Artillery, C.F.A.
McCuaig, O. B., Q.M.S., '04; 2nd Field Co., 3rd Bde.
Macdonald, C. E., Lieut., '16; F.O. Co., C.E.
Macdonald, W. A., Pte., '14; 2nd Pioneers Bn.
MacDonald, H. H. R., '11; Royal Sussex Regt.
MacDonald, J. A., Pte., '17; 2nd Div. Cycle Corps.
McDonald, K. D., Gnr., '15; 25th Bty., C.F.A.
MacDonald, R. A., Pte., '16; 54th Bty., C.F.A.
MacDonell, I. M., Lieut., '15; Corps of Guides.
MacDougall, A. C., Lieut., '01; Canadian Engineers.
McAllister, A. L., Lieut., '93; Canadian Engineers.
McArthur, A. S., '09; 35th Bn.
McCaffrey, W. R., '15; Cycle Corps.
McCarthy, T. V., Gnr., '13; 43rd Bty.
McEachern, F. Y. P., Lieut., '09; 198th Bn.
McEwen, G. A., Gnr., '17; 47th Bty.
Macfarlane, A. H., Pte., '16; C.E.F.
Magann, G. L., Lieut., '15; Div. Ammunition Col.
McGavin, P. L., Lieut., '18; Imperial Army.
McGhie, W. G., Lieut., '11; 35th Bn.
MacGregor, A. E., '10; 142nd Bn.
McIntyre, P. F., Lieut., '18; 67th O.S. Depot Battery.
McKague, E. V., Lieut., '15; Divisional Cycle Corps.
MacKay, E. G., Lieut., '10; 91st of Hamilton.
MacKendrick, G. K., Lieut., '18; 81st Bn.

†MacKenzie, A. M., Pte., '14; M. G. Sec. 19th Bn.
MacKenzie, H. J., Lieut., '14; Canadian Engineers.
MacKenzie, J. A., Sapper, '19; Divisional Signal Co.
McKinley, F. A., Gnr., '17 25th Bty., C.F.A.
McKirdy, W. S., '11; Divisional Signal Co., C.E.
MacLachlan, W.A., Lieut., '09; 134th Bn.
Maclaren, H. J., Lieut., '18; Reserve Bde., C.F.A.
McLaren, A. J., Lieut., '11; Cameron Highlanders.
MacLean, A. P., '17; 20th Bn.
MacLennan, G. G., '10; R. F. C. (Naval Wing).
MacLeod, D. D., '10.
McMillan, J. G., Lieut., '00; Royal Engineers.
McMordie, H. C., Capt., '08;
McPherson, F. T., L.-Cpl., '16; 2nd Univ. Co., P.P.C.L.I.
McPherson, W. B., Capt., '11; Course at S. of I.
MacQuarrie, A. H., Sapper, '14; Divisional Signal Co., C.E.
McQueen, A. A., Lieut., '11; 29th Bty.
Macqueen, C. B., '19; 201st Bn.
McSloy, J. I., Capt., '10; 20th Bn.
MacTavish, H. J., Lieut., '10; R.F.A.
MacTavish, W. H., '13.
McVean, J. H., Lieut., '18.
McMurtry, L. C., '19; 67th O.S. Bty., U. of T.

Madill, H. H., Capt., '11; Instr., S. I., No. 2 Div.
Maguire, J. R., 2nd Lieut., '19; 14th West Yorkshires, B.E.F.
Malcolm, F. R., Lieut., '19; Imperial Army.
Manning, T. R., Lieut., '16; 74th Bn.
Mansell, G. R., L.-Cpl., '14; 3rd Divisional Cycle Corps.
‡Marani, F. H., Lieut., '16; 3rd Bn.
Marlatt, K. D., Capt., '08; 20th Bn.
Marshall, J. A. P., Lieut., '14; Canadian Engineers.
°Mason, D. H. C., Capt., '07; 3rd Bn., 1st Bde. (Missing).
Matthews, F. J., Gnr., '16; 25th Bty., C.F.A.
Mayberry, F. C., '17; 25th Bty.
Mendizabal, A. R., Gnr., '16; 23rd Bty., 6th How. Bde.
Merriman, H. O., Flt.-Sub-Lieut., '10; Royal N. A. S.
Merry, F. S., Gnr., '16; 25th Bty, 7th Bde.
Metcalfe, W. F., '19; Divisional Signal Corps.
Michell, A. V., '19; 67th O.S. Bty., U. of T.
Miller, D. J., Lieut., '10; 4th Field Co., C.E.
Millar, W. G., Lieut., '14; Course of S. of I.
Milligan, F. S., Lieut., '10; Imperial Army.
Millman, N. C., Lieut., '13; R.M.A.C.
Mills, G. G., Capt., '07; Artillery course.
Mills, L. G., Lieut., '11; 74th Bn.
Mills, P. H., Sgt., '14; 31st Bty, C.F.A.
Milne, J. W., Pte., '19; Divisional Signallers.
*Mitchell, C. H., Lt.-Col., '92; G.S.O. (awarded D.S.O.; La Legion d'Honneur Croix d'Officier).
Mitchell, F. L., Lieut., '17; 83rd Bn.

Mitchell, G., Lieut., '15; Imperial Army.
Mitchell, J. S., Lieut., '14; 12th Regt.
Mitchener, J. R., Lieut., '18; 4th Univ. Co., P.P.C.L.I.
Molesworth, G. N., Capt., '07; 124th Bn.
Monds, W., Lieut., '99; Canadian Engineers.
Monteith, E. M., Capt., '15; 97th Militia Regt.
Monteith, J. C., Pte., '19; 110th Bn.
Moody, F. H., Major, '08; 116th Bn.
Moorehouse, E. L., Gnr., '17; 26th Bty.
Morice, J. H., Lieut., '08; Canadian Engineers.
Morphy, J. A., Major. '11; 2nd Contingent.
Morris, B. M., Lieut., '15; 59th Bn.
Morris, W. G., '19; 67th O.S. Bty., U. of T.
Morton, C. O., Sapper, '19; Divisional Signal Co.
Muir, J. M., Lieut., '15; 127th Bn.
‡Mulqueen, F. J., Lieut., '13; 172 Mining Co., R.E.
‡Munro, A. H., Sapper, '10; 5th Field Co.
Murdie, W. C., '13.
Murton, J. C., Lieut., '11; C. F.A.
Murray, W. P., Lieut., '08; C.P. Ry. Constr. Corps.
Musgrave, J. E. T., '18; 67th O.S. Bty., C.F.A.

Nash, J. C., '10.
Neelands, R. E. K., Sgt., '07; 43rd Bty.
New, R. H., Lieut., '10; 1st F. T., C.E.
Newton, J., Lieut., '09; 67th O.S. Depot Bty.
‡Nichol, F. T., Capt., '10; 100th Bn.
Nicholson, H. R., Lieut., '17; 13th Royal Regt.
Nixon, W. H., '18; Divisional Cyclist Corps.
Norris, A. F. C., Pte., '17; 20th Bn.
Norwich, H. B., L.-Cpl., '16; 2nd Div. Cycle Corps.
Norval, T. H., '18; Divisional Signalling Co.

Oke, W. V., Lieut., '11; 35th Bn.
Ormsby, J. A. N., Lieut., '16; Eaton Machine Gun Bty.
Orr, H. W., '18; 26th Bty., C.F.A.
Oxley, A. C., Capt., '10; 2nd Field Co.

Panter, J. S., Gnr., '16; H.Q. St., 4th Bde.
Parker, A. H., Lieut., '14.
Parker, W. J., Sapper, '18; Divisional Signal Co., C.A.
Parkinson, N. F., Bom., '13; 4th Bde., 13th Bn.
Parsons, C. S., Lieut., '19; Corps of Guides.
Parsons, J. L. R., Major, '01; Gen. Steele's Staff.
Pearce, G. M., Lieut., '18; 124th Bn.
Pearson, H., Pte., Divisional Cycle Corps.
Penhale, T. W., Lieut., '18; Imperial Army.
Pepler, S. H., Lieut., '18; 124th Bn.
Peplar, S. J., Lieut., '11; Divisional Cyclist Depot.
Perry. C. V., '14; Royal Engineers.
Perry, F. M., Lieut., '98; 15th Bn.

Peterking, S. M., Sgt., '15; 41st Bty.
Pfrimmer, V. R., Gnr., '16; 25th Bty., C.F.A.
Phillips, A. M., '19; Course at R.M.C.
Phillips, W. E., Capt., '14; Royal Leinster Reg., 7th Bn.
Philp, E. B., Gnr., '19; 54th Bty.
‡Philp, W. M., Sapper, '09; 2nd Field Co., C.E.
Pollock, F. J., '19; Course at Kingston.
Powell, N. L., Lieut., '16; 208th Bn. (Signalling Officer).
Powell, W. D., Pte., '15; C.P.R. Construction Corps.
Pringle, J. E., Lieut., '16; Imperial Army.
Pullen, E. F., Capt., '05; 97th Rgt.
Purchas, C. M. G., Gnr., '17; H. Q. Staff, 4th Bde., C.F.A.

Qua, A. H., '08.

Raley, W. E., Cpl,'15., 2nd Field Co., Can. E., C.E.T.D.
Rayner, G. V., Lieut., '18; 86th Bn.
Read, F. N., Pte., '11; 2nd Univ. Co., P.P.C.L.I.
Redfern, W. B., Signaller, '08; Divisional Signalling Co.
‡Redman, W. B., Sgt., '15; 5th Field Co., R. C. Engineers.
Reed, H., Lieut., '17; Course at S. of I.
Reid, E. V., Lieut., '11; Royal Flying Corps.
‡*Reid, J. M., Lieut., '15; Seaforth Highlanders (awarded V.C.)
Relyea, J. D., Gnr., '17; Ammunition Column.
†Revell, G. E., Sapper, '99; 1st Field Co., Canadian Engineers.
Richardson, A. A., Lieut., '15; 93rd Bn.
Richardson, W. A., '11; H. Q. Staff, 3rd Bde.
Riddell, J. M., '13; Canadian Engineers.
Riley, G. W., Lieut., '19; C.A.S.C., Mechanical Transport.
Ritchie, J. E., Lieut., '13; 147th Bn. (Machine Gun Officer).
Ritchie, W. W., Lieut., '16; 35th Bn.
Robertson, A. R., Capt., '08; 169th Bn.
Robertson, J. M., Lieut., '14; 65th Royal F. Art.
Robertson, N. R., Capt., '06; 2nd Field Co., C.E.
Robertson, W. G., '18; 67th O.S. Bty, C.F.A.
Robinson, D. A., Lieut., '18; 99th Bn.
Rogers, C. H., Lieut., '06. On Sir Max Aitken's staff.
Rolfson, O., Lieut., '06; S. O. I. at London.
Rose, H. C., Lieut., '16; Imperial Army.
Rose, J. T., Hqts. Staff, '15; 48th Battalion.
Rose, R. R., '08; Black Watch.
Ross, A. C., Sgt., '15; Course at Kingston.
Rous, C. C., Capt., '13; Engineers.
Rowe, H. M., Lieut, '15; 71st Bn.
Rutherford, F. N., '04.
Rutherford, F. S., Corp., '14; 2nd Field Co., Canadian Engineers.
Rutley, F. G., Capt., '11; 83rd Bn.
‡Rutter, G. W., Lieut., '15; 4th Canadian Mounted Rifles.
†Ryerson, G. C., Capt., '05; 3rd Bn.
Ryan, T. L., Lieut., '17; 215th Bn.
Schell, M. D., Pte., '18; 5th University Co., P.P.C.L.I.

Schwartz, G. B., '16; Capt., Cycle Corps.
Scott, A. G., Lieut., '15; 82nd Bn.
Scott, C. A., Lieut., '09; 198th Bn.
Scott, E. H., Sgt., '15, Ammunition Column, 8th Bde.
‡Segre, B. H., '09; 13th Bn., 4th Bde.
Seibert, P. T., Sgt., '19; 160th Bn.
Serson, H. V., Lieut., '05; Canadian Engineers.
Seymour, N. F., '15; 5th Divisional Signal Co.
Sharman, J. E., Lieut., '17; Royal Flying Corps.
Sharp, M. C., Gnr., '13; 2nd Bty., C.F.A.
Shaw, W. E. V., Capt., '08; 52nd Bty., C.F.A.
Sheard, Paul, Lieut., '11; C.A.S.C., 3rd Divisional Train.
Sheppard, A. C. T., Cpl., '07; 4th Field Co., Canadian Engineers.
Sheppard, H. L., Lieut., '14; Course at Kingston.
Sherman, N. C., Capt., '10; Canadian War Purchasing Commis'n.
Shier, W. G., Gnr., '15; 25th Bty., 2nd Bde., C.F.A.
Shoebottom, L. R., Lieut., '17; .
Sills, C. P., Gnr., '11; 43rd How. Bty., C.F.A.
Sime, A. W., Lieut., '14; 35th Bn., M. G. Sec.
Simmers, J. A., Pte., '18; 2nd Univ. Co., P.P.C.L.I.
Simmons, J. F. L., Gnr., '15; 4th Bde., C.F.A.
Simpson, B. N., Lieut., '14; C. F. A.
Simpson, F. W., Sapper, '18; Divisional Signal Co.
Sinclair, C. E., Lieut., '14; Royal Irish Fusiliers.
‡Sinclair, I. M. R., Capt., '17; 13th Bn.
Sinclair, R. B., Lieut., '15; Royal Field Art., 3 B. Res. Bde.
Smith, A. H., Lieut., '99; 2nd Canadian Pioneers Bn.
Smith, C. H., '17; 25th Bty., 7th Bde., C.F.A.
Smith, D. A., Cpl., '04; 5th Bn.
Smith, F. L., Gnr., '10; 13th Bty., 4th Bde.
Smythe, Conn, Lieut., '16; 40th Bty., 7th Bde.
Smythe, G. M., Capt., '14; 76th Bn.
Sneath, Roy G., Lieut., '11; 3rd Div'l Canadian Engineers.
Snow, G. B., Lieut., '16; 134th Bn.
Souter, J. M., Lieut., '18; 133rd Bn.
Spencer, A. C., Lieut., '07; 2nd Can. Divisional Cavalry.
Standing, R. O., Pte., '14; 3rd Divisional Supply Col., C.A.S.C.
Stalker, C. H., Lieut., '18; G.G.B.G.
Steele, A. L., '10; A.S.C., Canadian Engineers.
Steele, W. A., Lieut., '15; Divisional Signalling Officer.
Steers, F. P., Lieut., '14; Canadian Engineers.
Stevenson, C. W. G., Gnr., '17; 29th Bty.
Stephenson, G. E., Sapper, '17; Divisional Signal Co.
Stewart, A. E., Lieut., '11; Signal Co., C.E.
Stewart, D. L. N., '05; 20th Bn.
Stewart, H., Pte., '16; 20th Bn., M. G. Sec.
Stock, J. J., Sapper, '08; Signal Co.
Storms, D. H., Lieut., '15; 8th Bty.
Stratford, G. S., Pte., '16; 2nd Univ. Co., P.P.C.L.I.
Strathy, J. M., Sapper, '13; Signal Co., C.E.

Stuart, H. B., Lieut., '08; 2nd Canadian Pioneers Bn.
Sutcliffe, C., Capt., '10; 77th Bn.
Sutherland, D., Lieut., '13; 110th Bn.
Swinnerton, A. A., Pte., '16; Divisional Cycle Corps.
Swinnerton, A. F. R. W., Lieut., '16; 166th Bn.
Szammers; Cpl., '11; 2nd Can. Pioneers Bn.

Tate, H. W., Capt., '09; 2nd Canadian Pioneers Bn.
Taylor, F. H., Lieut., '18; 204th Bn.
†Taylor, G. B., Lieut., '14; 15th Bn.
Taylor, J. S., '14; Motor Bty.
Taylor, R. E., '16; 2nd Contingent.
Ternan, R. E., '10; British Admiralty.
Thomas, A. M., Lieut., '16; Royal Flying Corps (Naval Wing).
Thomas, G. C., Lieut., '11; Imperial Army.
Thompson, C. C., Lieut., '17; 124th Bn.
Thompson, H. G., Pte., '18; 135th Bn.
Thompson, R. J., '19; Divisional Cycle Corps.
Thornley, J. H., Major, '08; 33rd Bn.
Tillson, L. B., '15; Imperial Army.
Tilston, J. A., '14; Canadian Overseas Construction Co.
Tindale, C. E. W., Gnr., '17; 48th Bty.
Tobin, K. E., '16; 1st Contingent.
Tom, J. A., Gnr., '15; 26th Bty, 7th Bde, C.F.A.
Torrance, R. D., Lieut., '11; 34th Bn.
Torrance, T. E., Lieut., '13; Course at Royal School of Art.
Trebilcock, J. A., Lieut., '15; 4th Bde., R.F.A.
Trees, A. G., Lieut., '09; Course at S. of I.
Tremayne, J. E., Lieut., '16; 127th Bn.
Twidale, E. A., Lieut., '14; Imperial Army, R.F.A.
Trywhitt, R., Lieut., '16; 215th Bn.
Tracy, G. F., '18; Divisional Signalling Co.
Tough, W. G., Lieut., '11; 14th Bty.

Utley, R. A., Pte., '10; 2nd Univ. Co., P.P.C.L.I.

°VanAllen, K. M., Lieut., '10; R.N.A.S.
VanNorman, C. P., Lieut., '08; 127th Bn.
Vaughan, O. D., Lieut., '17; C.A.S.C.
Verity, M. F., Lieut., '14; 125th Bn.
Vernon, A. A. H., Lieut., '18; 10th East Surrey Regt.
†VanSittart, G. E., Major, '05; 13th Bty., C.F.A.

Wait, G. E., Lieut., '17; 12th York Rangers, 220th Bn.
Walcott, W. D., Pte., '11; 5th Univ. Co., P.P.C.L.I.
Wallace, H. D., Lieut., '17; 234th Bn.
Wallace, H. D. M., Lieut., '14; Aviation Corps.
Wallace, J. S. M., Gnr., '17; 67th O.S. Bty., U of T.
Wallis, H. M., L.-Cpl., '16; Aide to Brig.-Gen. Wallis, 16th Bn.
Wallis, J. H., L.-Cpl., '15; 16th Bn. (Home on sick leave).
Ward, A. L., Sgt., '15; H.Q. Staff, No. 2 Div., under Major Dunn.

Ward, H. G., Sapper, '19; Divisional Signal Co.
Ward, John W., Gnr., '17; 25th Bty., 7th Bde.
‡Watson, M. B., Lieut., '10; Royal Engineers, Imperial Army (wounded in motor car accident).
Watts, E. M., Major, '11; 198th Bn.
Watts, R. E., Lieut., '13; 84th Bn.
Webster, D. B., Lieut., '15; R.C.H.A.
Webster, H., Lieut., '13; R.F.A.
Weldon, H. S., Lieut., '18; H.Q. Staff.
Wells, A. R., Lieut., '16; Imperial Army.
West, A. M., Lieut., '08.
West, C. W., Lieut., '15; Course at S. of I.
Whaley, A. B., Lieut., '16; R.F.A.
Wheelock, C. H., Pte., '16; 35th Bn., M. G. Sec.
Whiteside, J. L., Lieut., '10; 46th Bn.
Whitley, P. L., '14; U. of T. O.S. Training Co., C.O.T.C., C.E.F.
Wigle, G. B., Lieut., '18; C.A.S.C.
Wilcocks, W. S., '15.
Wilkes, G. H., Lieut., '11; R.E.
Willey, C. M., Lieut., '18; G.A.R., Imperial Army.
Williams, G. K., Sub-Flt.-Lt., '10; Mech. Supt., Air Training School at Detling.
Williams, J. N., Gnr., '15; 26th Bty., 7th Bde., C.F.A.
Williams, P. E., Lieut., '18; 124th Bn., Signal Officer.
Williams, R. E., Gnr., '16; Int. Corps, C. Fd. Art.
Willmott, L. E., Lieut., '17; 170th Bn.
‡Wilson, Dutch, '15; Sgt., 15th Bn.
Wilson, J. N., Lieut., '06; Course at Kingston.
Wilson, J. S., Gnr., '16; 26th Bty., 7th Bde.
Wilson, L. R., Lieut., '09; C.P.Ry. Construction Corps.
Wilson, W. S., Lieut., '16; 147th Bn.
Wimperly, C. C., Lieut., '18.
Withrow, W. J., Lieut., '90; 2nd Canadian Pioneers Bn.
Wood, F. A., Lieut., '18; G.G.B.G.
Wood, H. A., Lieut., '15; Royal Flying Corps.
Wood, N. C., Lieut., '17; Imperial Army.
Wood, R. F. B., Capt., '13; 123rd Bn.
‡Worthington, A. N., Major, '13; 169th Bn.
Wright, A. J., Sgt., '13; 74th Bn.
Wright, W. J. T., Lieut., '11; 67th O.S. Depot Bty.
Wylie, W. H., Lieut., '11; Canadian Engineers.
Wyman, H. K., Gnr., '11; 25th Bty., 8th Bde.

Youell, L. L., Lieut., '16; 43rd How. Bty., C.F.A.
Young, C. R., Capt., '03; Instr., S. of I., No. 2 Division.
Young, J. F., Gnr., '17; 25th Bty., 7th Bde. C.F.A.
Young, T. J., '18; 25th Bty., 7th Bde., C.F.A.

NOTE.—Additions and corrections to this list will be appreciated by Prof. A. T. Laing, secretary of the Faculty.

# Applied Science

INCORPORATED WITH

## Transactions of the University of Toronto Engineering Society

*Volume X. New Series*
*May, 1915, to June, 1916*

PUBLISHED BY

The University of Toronto Engineering Society

ENGINEERING BUILDING
UNIVERSITY OF TORONTO, CANADA

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